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JOURNAL OF DAIRY SCIENCE

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OXIDIZED FLAVOR IN MILK

II. THE EFFECTS OF HOMOGENIZATION, AGITATION AND FREEZING OF MILK ON ITS SUBSEQUENT SUSCEPTIBILITY TO OXIDIZED FLAVOR DEVELOPMENT*

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Evidence that lecithin, rather than butter fat, may be the constituent of milk affected when oxidized flavor develops, was presented in the first of this series of studies on oxidized flavor (7). In continuing a study of the probable relation of lecithin to oxidized flavor development it was considered that processes which disturb the adsorbed layers on the fat globules might have some effect on the susceptibility of the milk to the development of this flavor.

There can be little doubt that homogenization of milk probably causes changes in the distribution of the materials adsorbed on the fat globules. Furthermore, Tracy, Ramsey and Ruehe (8) have shown that homogenization of milk lessens the intensity of the oxidized flavor that can be developed by the addition of copper followed by storage for 24 hours at 40° F. They state that the close relationship between the Eh values of the homogenized and non-homogenized milks indicates that the lessened intensity of the oxidized flavor developing in homogenized milk needs to be explained in some other way than on an oxidation-reduction basis.

Lundstedt (4) has presented evidence that the vigorous, mechanical agitation of milk while cold causes a movement of lecithin from the adsorbed layers on the fat globules to the plasma portion of the milk. Such a change might be expected to affect the susceptibility of the milk to oxidized flavor development if lecithin is the constituent oxidized when this flavor occurs.

Freezing and thawing probably cause some changes in the adsorbed layers on the fat globules as is evidenced by the oiling off of some of the

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The data presented herein are to be included in a thesis by W. Carson Brown in partial fulfillment of the requirements for the degree of Doctor of Philosophy, West Virginia University.

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butter fat when frozen milk is melted too rapidly. Doan and Baldwin (1) have shown that considerable pressure is exerted within cream when it freezes and conclude that this pressure is the causative factor of most importance in the destruction of the fat emulsion.

To test the effects of these processes on the susceptibility of milk to oxidized flavor development, the experiments herein reported, involving homogenization, agitation at low temperature, and freezing followed by thawing were carried out.

EXPERIMENTAL

The effect of homogenization. Homogenization of both raw and pasteurized milks was carried out at pressures ranging from none to 5,000 pounds per square inch. Samples of each batch of milk taken before passage through the homogenizer served as control samples. A sixty gallon per hour, single stage homogenizer was equipped with a 5-gallon supply tank having an outlet at the bottom to which was attached a sanitary fitting connected to the intake line of the machine. After the control sample was taken, the milk to be homogenized was placed in the supply tank and passed through the machine, first with no pressure applied and then with successive increases in pressure. Before the taking of each homogenized sample sufficient time was allowed for the milk homogenized at each increased pressure to reach the end of the short delivery pipe after leaving the homogenizing valve.

The pasteurization was carried out at 144° F. $\pm$ 1° with a 30-minute holding period. The pasteurized milk was homogenized immediately after the holding period without reduction in temperature other than that resulting while the milk was being brought to the homogenizer. The first five milks studied were from the mixed milk produced by the Experiment Station herd, and were drawn from a 150-gallon chromium-nickel-steel pasteurizer at the end of the holding period. The valve of the pasteurizer was made of brass, however, and a tendency for the development of oxidized flavor in this milk without the addition of copper other than that contaminating it while passing through the valve soon was apparent. The remaining milks studied were from cows selected because their milks were known to be susceptible to oxidized flavor development. The milk was drawn into aluminum buckets, cooled in an aluminum can immersed in ice water, and pasteurized later in the same can by immersion in a tank equipped with a cold water and a steam-inlet.

Raw milks studied were from cows selected as described above. The milks were drawn and held in aluminum utensils. They were homogenized at 90 to 100° F.

Each sample of milk was divided into two portions and a known amount of copper, as copper sulphate dissolved in water, was added to one portion. The concentration of the copper sulphate solution added was so regulated

that not more than 2 ml. of the solution per quart of milk was necessary when making additions of 1.3 and 2.6 parts per million of copper. Following this treatment the samples were stored for three days at about 40° F., according to the method of Guthrie and Brueckner (2), after which the occurrence of oxidized flavor was determined by taste.

The results of these studies are shown in Table 1.

The non-homogenized samples to which no copper had been added and which were not contaminated with copper by contact with surfaces exposing this metal did not become oxidized in flavor, but milks 1 to 5 inclusive evidently were contaminated sufficiently when passing through the brass valve of the pasteurizer to cause them to become oxidized. The development of oxidized flavor in all the non-homogenized samples to which copper was added shows that these milks were susceptible with respect to oxidized flavor. The tendency for the milks passed through the homogenizer without pressure to develop this flavor is evident, and is to be explained on the basis of copper contamination from the cylinder block and valves of the machine in the cases where no previous contamination had occurred. However, homogenization at pressures as low as 500 pounds either reduced the intensity of the oxidized flavor resulting after the addition of copper or prevented it altogether. In no case was oxidized flavor developed in milks containing added copper when the homogenzing pressure was 3000 pounds or more. As was expected, the homogenization of raw milk samples caused the development of very pronounced rancid and bitter flavors.

The effect of agitation. In order to obtain information on the effect of agitation of cold milk on the transfer of lecithin from the adsorbed layers on the fat globules to the plasma, in addition to that furnished by Lundstedt, three trials were carried out in which milk kept at 33° F. was agitated vigorously for two and one-half hours by means of a Lightnin mixer. Samples of agitated and non-agitated milk from the same original source, were separated and the lecithin content of each sample was determined by the method of Horrall (3). In order to make the results comparable each cream was standardized to 40 per cent butter fat on the basis of the Babcock test, with the skimmilk just separated from it.

The results of this study are shown in Table 2. An examination of the data shows that in each of the three cases agitation caused a reduction in the lecithin content of the cream and a corresponding increase in the lecithin content of the skimmilk. These results indicate that agitation did cause a movement of a portion of the lecithin adsorbed on the fat globules to the plasma. If the skimmilk had contained no butter fat whatever its lecithin content might be expected to show the amount of non-adsorbed lecithin occurring in the plasma portion of the milk, provided also that no movement of lecithin between the adsorbed layers on the fat globules and the plasma occurred as the result of warming and separating the milk. Considering

TABLE 1

The effect of homogenizing milk on its susceptibility to the development of oxidized flavor

TREATMENT	COPPER ADDED (P.P.M.)	MILKS PASTEURIZED IN 150-GALLON PASTEURIZER					MILKS PASTEURIZED IN ALUMINUM CANS									RAW MILKS			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Not homogenized	None	4	?	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.3	4	4	2	2	4	4	2											
	2.6								4	3	4	4	4	4	3	5	3	4	5
Homogenized, no pressure	None			4	4		–		–		–	3	4		4	3	–	1	3
	1.3			2	2		2												
	2.6								1		1	3	3		3	2	3	1	4
Homogenized, 500 pounds	None			–	–		–		–		–	1	–	2	–	–×	–×	–×	–×
	1.3			?	–		?												
	2.6								–		3	2	3	2	3	–×	–×	–×	–×
Homogenized, 1000 pounds	None			–	–		–		–	–	–	–	–	–	–	–×	–×	–×	–×
	1.3			–	–		–												
	2.6								–	–	2	1	1	1	1	–×	–×	–×	–×
Homogenized, 1500 pounds	None			–	–		–	–	–	–	–	–	–	–	–	–×	–×	–×	–×
	1.3			–	–		–	–											
	2.6								–	–	–	1	1	–	–	–×	–×	–×	–×
Homogenized, 2000 pounds	None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–×	–×	–×	–×
	1.3	–	–	–	–	–	–	–											
	2.6								–	–	–	1	–	–	–	–×	–×	–×	–×
Homogenized, 3000 pounds	None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–×	–×	–×	–×
	1.3	–	–	–	–	–	–	–											
	2.6								–	–	–	–	–	–	–	–×	–×	–×	–×
Homogenized, 4000 pounds	None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–×	–×	–×	–×
	1.3	–	–	–	–	–	–	–											
	2.6								–	–	–	–	–	–	–	–×	–×	–×	–×
Homogenized, 5000 pounds	None	–	–	–	–	–	–	–	–	–	–					–×	–×	–×	–×
	1.3	–	–	–	–	–	–	–											
	2.6								–	–	–					–×	–×	–×	–×

Meaning of symbols: –, no oxidized flavor; ?, may or may not have been oxidized; 1, very slight oxidized flavor; 2, slight oxidized flavor; 3, moderate oxidized flavor; 4, fairly pronounced oxidized flavor; 5, pronounced oxidized flavor; 6, very pronounced oxidized flavor; ×, rancid and bitter.

TABLE 2

The effect of agitating milk for two and one-half hours with a Lightnin mixer on the percentage of lecithin in the cream and skimmilk subsequently separated

MILK NO.	TREATMENT	CREAM		SKIMMILK	
		Butterfat*	Lecithin	Butterfat*	Lecithin
		Per cent	*Per cent*	*Per cent*	*Per cent*
1	Not agitated	40	.1673	.03	.0148
	Agitated	40	.1118	.03	.0168
2	Not agitated	40	.1618	.025	.01225
	Agitated	40	.1503	.02	.0126
3	Not agitated	40	.1898	.025	.01135
	Agitated	40	.1535	.025	.0122

* Determined by Babcock method.

the skimmilk as fat-free, and assuming that no movement of adsorbed lecithin or plasma-lecithin took place as the result of warming and separating the milk, the movement of lecithin from the adsorbed layers on the fat globules to the plasma could be calculated in the case of milk No. 1 as follows:

$$\frac{[.1673 - (60 \times .000148)] - [.1118 - (60 \times .000168)]}{.1673 - (60 \times .000148)} \times 100 = 35.8 \text{ per cent}$$

The corresponding percentages for milks Nos. 2 and 3 would be 7.6 and 20.1 respectively.

Even allowing for errors in the assumptions made, a movement of lecithin from the fat globule surfaces to the plasma as the result of agitation is indicated by these results. The variations in the values obtained suggest that the different milks may have contained different amounts of adsorbed lecithin before they were agitated, or that there were differences in the effectiveness of agitation possibly as the result of variations in the amount of milk in the container in which the agitation was carried out.

The effect of agitating for 2½ hours with a Lightnin mixer on the susceptibility of milk to the development of oxidized flavor was determined also. Milks from cows known to be producing susceptible milks were drawn and handled in aluminum utensils until the end of the process of agitation, when a sample containing no added copper and samples containing 1.3, 2.6, and 3.9 parts per million of added copper, respectively, were stored in milk bottles for three days at about 40° F. and then tasted. Nine samples of pasteurized milk and five samples of raw milk were studied. Pasteurization was carried out in aluminum cans in the manner already described in the discussion of the homogenization studies.

The results of this study are recorded in Table 3.

TABLE 3

The effect of agitating milk on its susceptibility to the development of oxidized flavor

MILK	FLAVOR OF NON-AGITATED SAMPLES		FLAVOR OF AGITATED SAMPLES			
	No copper added	2.6 p.p.m. added cu	No copper added	1.3 p.p.m. added cu	2.6 p.p.m. added cu	3.9 p.p.m. added cu
Pasteurized Milks						
1	–	5	–*	–*	–*	1*
2	–	4	–*	–*	–*	–*
3	–	4	–*	–*	†*	2*
4	–	6	–*	–*	1*	3*
5	–	6	–*	–	1	2
6	–	5	–*	–*	1*	3*
7	–	5	–*	–*	–*	1*
8	–	5	–*	–*	–*	3*
9	–	4	–*	–*	–*	1*
Raw Milks						
10	–	4	–×	–×	–×	–×
11	–	5	–×	–×	–×	–×
12	–	6	–×	–×	–×	–×
13	–	5	–×	–×	–×	–×
14	–	5	–×	–×	–×	–×

* Cream plug. × Slight rancid flavor.

For explanation of other symbols see Table 1, footnotes.

All milks in this series were agitated two and one-half hours with a Lightnin mixer. The container was immersed in ice water during agitation.

The results recorded in Table 3 show that, although the milks used were highly susceptible to oxidized flavor development before they were agitated, nevertheless prolonged agitation greatly reduced or eliminated this susceptibility. Extensive changes at the fat globule surfaces are indicated by the fact that the agitation of raw milks caused the subsequent development of rancid flavor in every case. Cream plugs, formed on all the pasteurized milks, also indicate that changes at the fat globule surfaces occurred as the result of agitation. Examination under the microscope showed many of the fat globules to be irregular in shape and some of them to be coalesced.

Agitation for two and one-half hours constitutes rather drastic treatment. To determine the effects of varying times of agitation, relatively large samples were agitated for a two and one-half hour period and samples were removed 5, 15, 30, 45, 60, 90, 120, and 150 minutes, respectively, after agitation was begun. The susceptibility of the milks agitated for the varying lengths of time was determined as before. Three pasteurized and three raw milks were studied in this experiment.

The results, recorded in Table 4, show little effect of agitation on susceptibility until the milks had been agitated for 45 minutes of longer. Agitation for 150 minutes (two and one-half hours) made the milks non-susceptible

TABLE 4

The effect of length of agitating period on the susceptibility of milks to oxidized flavor development

STIRRING PERIOD	COPPER ADDED (P.P.M.)	PASTEURIZED MILKS			RAW MILKS		
		1	2	3	1	2	3
Not agitated	None	–	–	–	–	–	–
Not agitated	2.6	6	4	5	4	4	5
5 minutes	2.6	4	3	4	2	3	4
15 minutes	2.6	4	3	4	2	3	4
30 minutes	2.6	3	3	3	2	3	3
45 minutes	2.6	1	3	3	1	2	3
60 minutes	2.6	1	2	–*	1	2	2
90 minutes	2.6	1	1*	–*	1	2	2
120 minutes	2.6	?*	–**	–**	?	1×	–×
150 minutes	2.6	–*	–**	–**	–×	–×	–×

* Slight cream plug. ** Moderate cream plug. × Slight rancid flavor.
For meaning of other symbols see Table 1, footnotes.

in these trials. A close relationship between the formation of a cream plug and the reduction in susceptibility is evident. Samples of raw milk No. 1 not agitated and agitated for 5, 60, and 150 minutes, respectively, were examined under the microscope. The sample agitated 60 minutes showed only slight evidence of churning, but definite evidence of churning was apparent in the sample agitated 150 minutes. No cream plugs occurred on the raw milk samples after agitating. It is interesting to note also that slightly rancid and bitter flavors occurred in all the raw milk samples that had been agitated for 150 minutes and in some of these samples after 120 minutes of agitating.

The effect of freezing and thawing. In studying the effect of freezing and thawing on the susceptibility of milks to oxidized flavor development, milks were used from cows known to be producing susceptible milks. The milks were handled entirely in aluminum and glass containers. As in the other experiments herein reported, the susceptibility of the milks was determined by the addition of copper sulphate solution in concentrations such that the addition of not to exceed 3 ml. of the solution per quart of milk was necessary to yield the concentrations of added copper desired. Samples were frozen in aluminum cans in still air at 0° F. by storage at this temperature for 24 hours. They were thawed at 70° F. with a minimum of agitation, after which they were cooled in ice water. Four samples of milk that had been frozen and thawed were prepared in quart milk bottles containing no added copper and 1.3, 2.6, and 3.9 parts per million of added copper, respectively. After preparation all samples were stored 3 days at about 40° F. and then tasted.

The results of this experiment, recorded in Table 5, show that freezing and thawing under the conditions obtaining caused the reduction or elimina-

TABLE 5

The effect of freezing and thawing on the susceptibility of milk to oxidized flavor development

MILK NO.	NOT FROZEN				FROZEN AND THAWED			
	Parts per million added cu				Parts per million added cu			
	None	1.3	2.6	3.9	None	1.3	2.6	3.9
				Raw Milks				
1	–	–	1	1	–	–	–	1
2	–	3	3	3	–	–*	–*	2*
3	–	4	3	2	–*	–*	–*	–*
4	–	1	3	2	–*	–*	–**	–**
5	–	3	3	3	–	–*	1*	1*
6	–	3	4	2	–	2*	2*	2*
7	–	2	3	3	–	2	3	2*
				Pasteurized Milks				
1	–	2	2	2	–*	–*	–*	–*
2	–	4	3	2	–*	2*	2*	1*
3	–	4	3	3	–*	–*	–*	1*
4	–	3	2	2	–**	–**	–**	–**
5	–	5	2	2	–	2	1	2
6	–	4	4	3	–**	–**	–**	–**
7	–	2	2	2	–**	–**	2**	2**

* Slight cream plug. ** Excessive cream plug.
For meaning of other symbols see Table 1, footnotes.

tion of the susceptibility of the milks to oxidized flavor development. A close relationship between this effect and the occurrence of cream plugs containing relatively large particles of butter fat, that presumably oiled off during thawing, was observed. Whenever an excessive cream plug was observed the milk failed to develop oxidized flavor even with 3.9 parts per million of added copper, but when a less pronounced cream plug was observed some development of oxidized flavor usually was evident.

SUMMARY AND DISCUSSION

The results of these studies show that treatments of milk by homogenization, by agitation at low temperature, and by freezing and thawing have marked effects in reducing or eliminating the susceptibility of milk to oxidized flavor development when stored after addition of sufficient copper to cause the development of oxidized flavor in the non-treated milk. Also, vigorous, prolonged agitation of milk at low temperature was shown to cause some movement of lecithin from the adsorbed layers on the fat globules to the plasma.

A consideration of these experiments does not yield any clear-cut explanation of the phenomena observed. The work of Tracy, Ramsey and Ruehe (8) indicates, as already pointed out, that the effect of homogenization in lessening the susceptibility of milk to oxidized flavor development is not to be explained on the basis of changes in the oxidation-reduction potential. The striking similarity in the effects of each of the three treatments, *i.e.*, homogenization, agitation and freezing followed by thawing, appears to be that each probably causes at least some realignment of the materials adsorbed on the fat globules. Lecithin undoubtedly is concerned in this realignment as was shown in the experiments studying the effects of agitation. However, the manner in which either the lecithin or the butter fat may be protected from oxidation as the result of these treatments is not evident.

If a transfer of nearly all the lecithin from the adsorbed layers on the fat globules to the plasma were caused by these treatments, a conclusion would be indicated that lecithin in the adsorbed layers on the fat globules is oxidized readily to give rise to oxidized flavor, whereas lecithin dispersed in the plasma, but not adsorbed on the fat globules, is not oxidized in this manner. Evidence that lecithin in the plasma is not affected to produce oxidized flavor was obtained in three trials with milk and with sweet-cream buttermilk from cream separated from the same milk. Samples of milks obtained and handled in the same manner as in the experiments on freezing were pasteurized, cooled and stored at 40° F. for three days after the addition of known amounts of copper as in the experiments herein reported. All three milks were found to be susceptible. Each milk, free from previous contamination with copper or iron, was separated by means of a De Laval separator and churned by shaking in a small aluminum can. The cream was churned at low temperature and the process was carried out in a room kept at about 40° F. Gloves were worn during the shaking process to avoid appreciable heat transfer to the cream. It was hoped that by observing these precautions very exhaustive churning would result. The buttermilks obtained were tested for their susceptibility to oxidized flavor development by the method used for the milks in the preceding experiments.

The results are shown in Table 6. Buttermilk from milk No. 1 was relatively low in butter fat content (0.6 per cent) and the buttermilk from milk No. 2 was exceedingly low in butter fat content (0.035 per cent). Neither of these buttermilks developed oxidized flavor. Although a metallic taste was quite evident in both buttermilks containing either 2.6 or 3.9 parts per million of copper, their flavor was entirely unlike the oxidized flavor developed in the milks which were the sources of these buttermilks. The buttermilk from milk No. 3 contained 3.8 per cent of butterfat, and a very slight but typical oxidized flavor was evident in the samples containing 2.6 and 3.9 parts per million of added copper. As churning is known to cause

TABLE 6

The susceptibility of sweet cream buttermilk to oxidized flavor development

MILK NO.	ORIGINAL MILK : FLAVOR				BUTTERMILK : BUTTER FAT CONTENT AND FLAVOR				
	Copper added (p.p.m.)				Butter fat*	Copper added (p.p.m.)			
	None	1.3	2.6	3.9		None	1.3	2.6	3.9
					per cent				
1	–	4	2	2	0.6	–	–	–	–
2	–	4	3	2	0.035	–	–	–	–
3	–	3	2	1	3.8	–	–	1	1

* Determined by Babcock method.

For meaning of other symbols see Table 1, footnotes.

the removal of most of the adsorbed lecithin from the fat globules and its dispersion in the buttermilk these investigations indicate that lecithin, when not adsorbed at the fat globule surfaces, may not be oxidized to produce the typical oxidized flavor. The development of oxidized flavor in the buttermilk from milk No. 3 may be explained on the basis that because of its relatively high butterfat content, a considerable number of fat globules remained on which, presumably, the lecithin was oxidized to produce the oxidized flavor noted. Reference was made in the first of this series of articles to the fact that Thurston and Barnhart (6) observed the occurrence of oxidized flavor in sweet cream buttermilk. It should be noted that the buttermilks produced in those experiments probably contained some non-churned butterfat and therefore would be expected to show oxidized flavor development in the same manner as did sample No. 3 in this experiment.

It must be recognized that the transfer of lecithin from the fat globules to the plasma as the result of agitation was far from quantitative in the case of these experiments, and that the probability of such a transfer as the result of homogenization or of freezing and thawing is extremely remote. However, it appears from these experiments with churning that any lecithin so transferred would not be affected so as to produce oxidized flavor.

The possible significance of the formation of cream plugs in all pasteurized milks that were agitated 120 minutes or longer, and in nearly all the milks that were frozen and thawed, deserves consideration. Sommer and Royer (5) have shown that cream plug formation is the result of partial churning. This fact would suggest that the transfer of some lecithin from the adsorbed layers on the fat globules to the plasma as the result of agitation or of freezing and thawing is caused by partial churning, as churning is known to have this effect. However, as only partial churning occurred and only part of the lecithin was shown to move from the fat globules to the plasma in severely agitated milk it would seem that the partial churning observed cannot account for the complete protection of the milk from

oxidized flavor development. The data herein reported do not yield an adequate explanation of this point.

It is likely that freezing of milk followed by thawing does not have so extreme an effect as severe mechanical agitation. The data show that many of the milks frozen and thawed were reduced in their susceptibility to oxidized flavor development but were not rendered entirely non-susceptible. This fact would suggest that the reduction in susceptibility was the result of the freeing of lecithin from coalesced fat globules but that other fat globules remained unchanged and permitted the development of oxidized flavor.

Although homogenization has the same effect in rendering milk non-susceptible to oxidized flavor development as severe mechanical agitation and freezing followed by thawing, the effect of homogenization on the physical constitution of milk is so different from the effects of the other two treatments studied that it would be difficult to explain all these effects on the same basis. A number of possibilities have been considered, but as they lack foundation in experimental demonstration they are left for future study.

CONCLUSIONS

Homogenization, prolonged agitation at low temperature, and freezing and thawing of milk reduce or eliminate its susceptibility to oxidized flavor development.

These results seem to lend support to the previous evidence obtained by the authors that lecithin rather than butterfat probably is the constituent of milk affected when oxidized flavor develops.

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THE INFLUENCE OF THE PHYSICAL STATE OF THE FAT ON THE CALCULATION OF SOLIDS FROM THE SPECIFIC GRAVITY OF MILK

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INTRODUCTION

At least 36 different equations for calculating the relationship between the specific gravity and the fat and plasma solids content of milk have been published in the past 75 years. The first equations proposed dealt with the determination of the fat content from the specific gravity and the total solids content, because at that time no simpler method for the determination of fat in milk was available. With the development of the Babcock and Gerber methods for the determination of fat, the use of the equation shifted to the determination of the total solids, or plasma solids, from the fat content and the specific gravity.

It has been a rather common observation that the equations work well only when applied to the data from which they are derived. They usually fail, particularly when used by another investigator. This has led to the substitution of a long list of different constants in the fundamental equation expressing this relationship, and to the addition or subtraction of arbitrary constant factors to make the calculated results agree with the experimentally determined values.

It is surprising that such variations should exist in the proposed equations for expressing a simple relationship between apparently simple physical constants. The existence of unrecognized and uncontrolled variables in the system is indicated.

A large part of this lack of agreement and reproducibility is due to one factor which has never been limited adequately, namely, the lag in the change in the physical state of the fat in the globules as the temperature is adjusted to that at which the specific gravity is determined. The determinations are almost invariably made at 60° F. (the temperature specified by health and food officials of the United States) or at 15° C. in some parts of Europe. With or without limitations as to the previous heat treatment of the milk, work in this laboratory has indicated that a more unsatisfactory temperature for making the specific gravity determinations could not be found. Fat in the globules of milk does not melt or dissolve and solidify or crystallize as the temperature is changed, as rapidly as does milk fat in mass. Since each globule is an isolated unit, crystallization of one globule does not by seeding induce crystallization in any other globule. Conse-

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quently there is a much greater lag in the melting and particularly in the solidification of the fat in the globules as contrasted to the change in physical state of fat in mass. This lag in both effects is at a maximum in the region of 15° C. A sample of milk which has been held cold for some time and then is warmed to 15° C. will have a greater specific gravity than a sample of the same milk which has been held warm and is then cooled to 15° C. This difference is due to the fact that the fat in one case is mostly in the solid state at 15° C. and in the other mostly in the liquid state. Solid fat at this temperature has a higher specific gravity than does liquid fat at the same temperature.

The expected variations in the physical state of the fat explain the following observations which have been reported in the literature:

(1) That night's milk is more dense than morning's milk (the determinations of the morning's milk being made soon after milking, while the evening's milk was held over night in a refrigerator).

(2) That winter's milk is more dense than summer's milk (the milk being cooled more in winter).

(3) That correction factors fail to give satisfactory results when the specific gravity is determined at some temperature other than 15° C. and is then corrected to 15° C.

(4) That the specific gravity of milk increases with age (the milk being kept cold).

The fact that the specific gravity of milk increases on standing has been known for about 80 years. The textbooks on dairying refer to this increase in specific gravity as Recknagel's phenomenon. Recknagel (2) determined some of the conditions under which the increase in specific gravity occurred. He showed that the escape of air bubbles was not the factor, but attributed the increase in specific gravity to an increase in the hydration of the casein at the lower temperatures. He did not study skim-milk. Toyonaga (5), working with Soxhlet, attributed the increase to the solidification of the fat and reported that the process could be repeated by warming and again cooling. He found that almond oil when emulsified in a gum solution showed no increase, whereas a 4% emulsion of milk fat in gum solution showed the same increase in specific gravity on standing at 15° C. as did whole milk. Richmond (3) states that Recknagel's phenomenon is due largely to the increase in density of the fat.

In several cases it has been possible to learn the previous history of the samples of milk used by investigators in developing their equations, and in each case the previous history of cooled or warmed milk was reflected in the constants of the equation proposed.

This investigation was undertaken to show that much of the previous difficulty in establishing the relation between the specific gravity of milk

and its composition could be accounted for by failure to realize the disturbing influence of variations in the physical state of the fat, and to devise a simple procedure for determining the specific gravity of milk under conditions which would permit no such variation.

METHOD USED TO DETERMINE THE SPECIFIC GRAVITY

The ordinary laboratory form of the Westphal balance does not have the sensitivity desired, and therefore a more sensitive one was constructed from an ordinary chainomatic weighing balance. A sinker of sealed glass tubing, having a displacement of approximately 25 cc. and weighted with sufficient mercury, was suspended from one arm of the balance. The sinker was suspended by a small platinum wire sealed into one end of the sinker. The portion of the wire which passed through the surface of the liquid was first rubbed with a small amount of oleic acid to decrease the influence of surface tension on the wire. The milk was contained in an insulated tall form beaker of 200 ml. capacity, which was supported over the pan of the balance. The milk was adjusted to the desired temperature with an accuracy of $\pm$ 0.1° C. The specific gravity could be determined with a reproducibility of 2 or 3 in the fifth decimal place. Care was taken to avoid: the presence of air bubbles in the milk; the uneven distribution of fat; and changes in temperature. The specific gravity was obtained by dividing the weight of milk displaced by the bulb, by the weight of air-free, distilled water displaced by the bulb, both displacements being determined at the same temperature.

The modified Westphal balance was used in this work because a simple, rapid method giving a high degree of accuracy was desired. If a high degree of accuracy is not desired, then a lactometer or hydrometer may be used. The accuracy of the results will depend upon the sensitivity of the lactometer. In any case the lactometer should be calibrated.

Effect of air bubbles

Errors arise if the specific gravity is determined too soon after milking, owing to the presence of small air bubbles. A sample of freshly drawn milk was brought at once to the laboratory, warmed to 45°, and cooled to 30° C. Its specific gravity was found to be 1.03335 at 30° C. After standing for 3 hours, the specific gravity was found to be 0.00007 higher. The air bubbles are relatively large, and they soon rise to the surface of the milk and rupture. This process can be hastened in the laboratory by placing the milk in an Erlenmeyer flask, placing the flask in a vacuum desiccator the bottom of which is covered with water, and applying a vacuum for a minute or two, at the same time causing the milk in the flask to swirl by rotating the desiccator.

Effect of previous temperature treatment on the specific gravity of milk at 15 and 30° C.

Samples of whole milk, which varied in respect to breed, stage of lactation, fat and solids-not-fat content, were studied. The specific gravity of each sample was determined after it was subjected successively to the four treatments shown in Table 1. Care was taken to prevent evaporation during the treatment and handling of each sample.

TABLE 1

Effect of warming and cooling on the specific gravity of whole milk at 15° C. (59° F.) and 30° C. (86° F.). Average of 30 experiments

	SPECIFIC GRAVITY
Held 24 hrs. at 2° C. Warmed to 15° C.	1.03236
Held ½ min. at 45° C. Cooled to 15° C.	1.03134
Difference	0.00102
Held 24 hrs. at 2° C. Warmed to 30° C.	1.03008
Held ½ min. at 45° C. Cooled to 30° C.	1.02998
Difference	0.00010

These data show clearly that appreciably different specific gravity values may be obtained for the same sample of milk, measured at 15° C., due to variations in the heat treatment of the milk before making the specific gravity determinations.

The variations are caused by the fat. This is shown by the fact that fat-free milk shows no such variation and by the fact that the variations in whole milk are linearly related to the fat content.

Fresh milk was held at 15° C. over night, cooled to 0° C. for an additional 24 hours, and then the specific gravity was determined after the following treatments: (1) warming to 15° C., (2) warming to 30° C., (3) warming to 45° C. and then cooling to 30° C., (4) cooling to 15° C. The differences between the specific gravity values obtained at each temperature are linearly related to the fat content of the samples as shown by Figure 1. The differences are more marked at 15° C. than at 30° C. The fact that a small difference was found at 30° C. indicates that warming to 30° C. was not sufficient to melt the fat completely.

In other experiments in which the milk was cooled to 2° C. without the preliminary holding at 15° C. the points were more widely scattered when plotted. This indicates a lack of uniformity in the solidification. Sharp and Rishoi (4) found that the rate of cooling had a marked effect on the specific heat of milk. Consequently the rate of cooling would be expected to have an effect on the specific gravity.

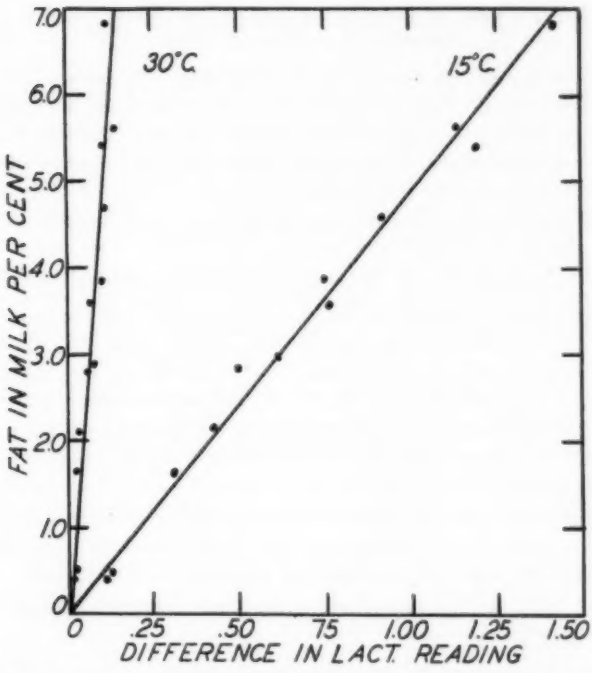

FIG. 1. RELATION BETWEEN FAT CONTENT OF THE MILK AND THE DIFFERENCE IN LACTOMETER READING AS INFLUENCED BY WARMING AND BY COOLING MILK TO 15° C. AND TO 30° C.

If the specific gravity is to be used in calculating the composition of the milk, the constants must be established and the specific gravity determinations must be made when the fat is in a definitely known and reproducible physical state. Almost of necessity the fat must be in the liquid state, because it is very difficult to obtain a definite degree of solidification.

Complete liquefaction can be accomplished by warming the milk to 45° C. (113° F.). Since this temperature is too high for convenience, it is recommended that the milk be cooled back to 30° C. (86° F.) for the determination of the specific gravity. At 30° C. no solidification or crystallization of the fat will occur, at least not until the milk has been held at this temperature for many hours.

It is apparent from a consideration of Table 1 and Figure 1 that deviations between the total solids of whole milk, as determined by drying and as calculated from the specific gravity determined at 15° C., may occasionally be as much as 0.5 per cent if the previous temperature history of the sample is diametrically opposite to that of the samples used in developing the equation. As examples, several equations which appear in the literature were tested and large deviations resulted.

Equations for calculating total solids from specific gravity determined at 30° C.

Equations for calculating the total solids from the fat content and the specific gravity of milk are of two forms: (1) those based on additive specific volumes which are correct for all specific gravities, and (2) those based on additive specific gravities which are correct only for the specific gravity at which the constants are determined.

The following is the type equation for additive specific gravities in which K_1 and K_2 are the constants:

$$\text{Total solids} = K_1\ (\text{Fat content}) + K_2\ (\text{Lactometer}) \qquad (1)$$

Equation (1) is the simplest form of the equation, and the one used most often, because the calculations are simpler, and if the deviations from the specific gravity at which the constants were determined are small, only a negligible error is introduced. For every lactometer degree above that at which the constants were determined, 0.007 is subtracted from the calculated total solids, and for every degree below, 0.007 per cent is added to the calculated total solids.

The following is the equation of additive specific volumes:

$$\frac{100}{\text{Sp. gr. milk}} = \frac{\text{Fat}}{\text{Sp. gr. fat}} + \frac{\text{T.S.} - \text{Fat}}{\text{Sp. gr. s.n.f.}} + \frac{100 - \text{T.S.}}{1} \qquad (2)$$

By simplification and grouping of constants, it can be changed into the following form for use:

$$\text{T.S. (Total Solids)} = K_3\,\text{Fat} + K_4\left(100 - \frac{100}{\text{Sp. gr. milk}}\right) \qquad (3)$$

The factor $\left(100 - \frac{100}{\text{Sp. gr. milk}}\right)$ converts the equation from additive specific gravities to additive specific volumes. This correction factor appears in the literature in the following forms which are equivalent:

$$10\left(100 - \frac{100}{\text{Sp. gr. milk}}\right) \qquad (4)$$

$$\left(1000 - \frac{1000}{\text{Sp. gr. milk}}\right) \qquad (5)$$

$$\left(\frac{1000\ \text{Sp. gr.} - 1000}{\text{Sp. gr. milk}}\right) \qquad (6)$$

$$\left(\frac{\text{Lactometer}}{\frac{1000 + \text{Lactometer}}{1000}}\right) \qquad (7)$$

$$\left(\frac{\text{Lactometer}}{\text{Sp. gr. milk}}\right) \qquad (8)$$

The factor 10 of (4) is removed from the K_4 in equation (3).

The following is the simplest form of the equation for additive specific volumes:

$$\text{Total Solids} = K_3\ \text{Fat} + K_4 \left(\frac{\text{Lactometer}}{\text{Sp. gr. milk}}\right) \qquad (9)$$

The total solids and fat content of 30 samples of milk from individual cows and 30 samples of gravity skimmed milk from the same samples were determined by the Mojonnier methods. The specific gravity of each of these 60 samples was also determined at 30° C., after warming to 45° C.

Three pairs of constants were calculated, by the method of least squares, for each of the equations (1) and (9). The constants calculated for the skimmilk alone gave appreciable errors when applied to whole milk, and constants calculated for whole milk gave slight but consistently lower values when applied to skimmilk. The most satisfactory pairs of constants were calculated from all of the data for both whole milk and skimmilk. They are substituted in the equations given below:

$$\text{Total solids} = 1.2648\ \text{Fat} + 0.2586\ \text{Lactometer} \qquad (10)$$

$$\text{Total solids} = 1.2537\ \text{Fat} + 0.2680 \left(\frac{\text{Lactometer}}{\text{Sp. gr. milk}}\right) \qquad (11)$$

The differences between the total solids as determined by drying, and as calculated from the fat content and the specific gravity, are given in Table 2. The samples included milk from the following breeds: Holstein, Jersey, Guernsey, Ayrshire, Brown Swiss, and Shorthorn. The composition of the milk ranged as follows:

	Whole milk	*Skimmilk*
Fat	3.07% to 6.77%	0.06% to 1.10%
Plasma Solids	8.33% to 9.56%	8.65% to 10.08%
Total Solids	11.66% to 15.85%	8.80% to 10.70%

The deviations in Table 2 are on the whole satisfactorily small. No relation between the deviations and the fat or plasma solids content was indicated when the data were plotted. Some of the deviations, especially in the whole milk series, columns 2 and 4, were larger than were expected. It is believed that the cause of the large deviations is to be found in the determination of the total solids by drying, and is not due to errors in the specific gravity method.

Errors in the determination of total solids by drying

The maximum errors involved in the various determinations, expressed in terms of total solids in the milk, were estimated to be as follows:

Fat, limit between duplicates	0.01%
Total Solids, limit between duplicates	0.05%
Specific Gravity, limit of variation	0.03%

If by chance all of these errors were to operate in one direction, the maximum deviation between the total solids as determined by the two methods

TABLE 2

Difference between the total solids as determined by drying and as calculated from the specific gravity determined after cooling to 30° C., and the fat content

COW NO.	EQUATION (10) ADDITIVE SP. GRAVITIES		EQUATION (11) ADDITIVE SP. VOLUMES		DIFFERENCE IN SOLIDS IN FAT FREE PLASMA CALCULATED FROM MILK AND SKIMMILK (5)	EQUATION (11) RECALCULATED T.S. OF WHOLE MILK USING	
	Skimmilk (1)	Whole milk (2)	Skimmilk (3)	Whole milk (4)		Skim plasma (6)	Average whole and skim plasma (7)
	%	%	%	%	%	%	%
1	−.04	−.04	−.04	−.04	+.02	−.04	−.05
2	−.08	+.11	−.05	+.12	−.14	−.05	−.04
3	−.20	+.14	−.21	−.14	−.03	+.07	00
4	+.04	+.15	+.03	+.16	−.05	+.05	+.07
5	−.06	+.01	+.05	+.01	+.06	−.03	00
6	−.06	−.05	−.06	−.05	−.01	−.06	−.07
7	−.02	+.07	00	+.08	−.06	+.05	−.02
8	−.17	−.03	−.19	−.05	−.12	+.10	−.06
9	−.07	+.05	−.07	+.06	−.07	+.02	+.05
10	−.15	−.30	−.12	−.29	+.25	00	−.12
11	−.03	−.02	−.02	+.03	−.04	+.02	00
12	−.04	+.05	−.05	+.04	−.03	+.03	−.01
13	−.03	00	−.03	−.02	+.05	+.01	+.08
14	−.01	+.13	−.01	−.12	−.03	+.13	+.15
15	+.02	−.10	+.01	−.21	+.25	−.07	−.04
16*	−.05	−.16	−.04	−.16	+.10	−.01	−.06
17	00	−.06	00	−.05	−.13	−.11	+.04
18	+.01	−.04	00	−.06	−.07	−.04	+.07
19	+.02	−.08	+.01	−.09	+.12	−.02	−.03
20	+.07	+.21	+.08	+.21	−.04	+.18	+.20
21	+.11	+.12	+.11	+.12	+.01	+.12	+.12
22	+.08	+.20	+.08	+.20	−.06	+.09	+.13
23	+.03	+.22	+.03	+.22	−.13	+.02	+.08
24	+.04	−.16	+.05	−.15	+.22	00	−.11
25	−.08	−.07	−.05	−.07	+.04	−.10	−.12
26	−.12	−.02	−.13	−.03	−.08	+.09	−.06
27	+.09	+.10	+.10	+.11	+.05	+.15	+.12
28	+.15	+.19	+.15	+.19	00	+.15	+.15
29	+.04	+.04	+.04	+.03	+.05	+.01	−.03
30	+.01	+.07	+.03	+.09	−.03	+.01	+.02
Mean error	−.017	+.024	−.010	+.001	+.001	+.026	+.015
Mean deviation	.064	.094	.061	.107	.081	.061	.070

would be 0.09 per cent. Several deviations are greater than this limit. The possible causes for these higher deviations were studied.

An error in the determination of the total solids in whole milk by drying was suspected because 14 samples of whole milk, column 4 of Table 2, showed deviations greater than 0.09 per cent, while only 7 samples of skimmilk exceeded this limit. This was shown to be the case by calculating the solids content of fat-free plasma, using in one case the whole milk analyses and in the other the skimmilk analysis. If no errors occurred in the determinations of fat and total solids, the results should be the same. The differences

between these two calculated values are shown in column 5 of Table 2. Although in every case the total solids as determined by drying represented the average of duplicates which did not deviate from each other by more than 0.05 per cent, yet errors as high as 0.25 per cent may have occurred in some of the determinations of dry matter of whole milk.

The deviations in column 4 plotted against column 5 of Table 2 showed a linear relationship. This indicates that the errors in the determination of the solids in whole milk by drying actually exceed the errors in the determination of the solids in whole milk by calculations from the specific gravity and the fat content. This was further shown by the fact that the deviations were decreased if the plasma solids as calculated from the skimmilk were substituted (by calculation) in the experimentally determined total solids of whole milk. Such a substitution (column 6) eliminated all but one of the large deviations in column 4. The substitution of the average of the solids in the plasma phase (column 7) of skimmilk and whole milk also reduced the deviations below those obtained by using the total solids as obtained by drying whole milk itself.

Insofar as small differences are concerned, the determination of dry matter in substances such as milk is essentially an arbitrary process, the actual values obtained depending on the technique employed. The results are affected by the condition of the sample, the accuracy of sampling, drainage of the pipette (even though the sample is weighed in the dish), time and temperature of drying, thickness of the layer in the dish, vapor tension of the air in the oven, and oxidation and decomposition of the organic material. Variations in drying technique may in some cases account for the lack of agreement between the total solids as determined by drying and as calculated from the specific gravity.

Effect of lactose

Variations in the amount of lactose should have little effect on the specific gravity of the plasma solids of milk, since lactose in solution has a specific gravity of about 1.63. This value is nearly the same as the specific gravity of the plasma solids which, according to our determinations, average 1.592 at 30° C. In order to make sure that lactose in milk exerted no untoward effect on the specific gravity, the specific gravity and total solids of a number of samples of milk were determined before and after the addition of 2 per cent of lactose. Calculations indicate that this addition should introduce a positive error of only 0.02 per cent. The results, expressed as the differences between the total solids as determined by drying, and by calculation from the specific gravity, are presented in Table 3. The total solids ranged from 8.91 to 14.07, and the fat from 0.09 to 5.30 per cent, in the samples examined. Variations in lactose content do not affect appreciably the reliability of the calculations of the total solids from the specific gravity.

TABLE 3

Effect of adding 2% of lactose to milk of various fat contents, on the deviation between the total solids as determined by drying and as calculated from the specific gravity

SAMPLE NUMBER	DEVIATION		EFFECT OF LACTOSE
	Before adding lactose	After adding lactose	
	%	%	%
1	−.02	0.00	+.02
2	−.07	−.06	+.01
3	−.02	−.11	−.09
4	−.07	+.04	+.11
5	+.01	+.04	+.03
6	+.02	+.04	+.02
7	+.05	−.02	−.07
8	+.09	+.10	+.01
9	+.12	+.01	−.11
10	+.04	+.03	−.01

Effect of citric acid

Most of the values for the amount of lactose present in milk are obtained by subtracting from the total solids of milk, the sum of the fat, protein and ash. The amount of lactose, therefore, may occasionally be in error in either direction, to the extent of the sum of all the errors in the above four determinations. In addition, such a method for determining lactose is in error to the extent of the amount of citric acid present in milk. By the above method the citric acid is calculated as lactose. The amount of citric acid present in milk is variously given as from 0.2 to 0.3 per cent. Citric acid in solution has a specific gravity of 1.68 at 30° C. Since the amount of citric acid present is small, and its specific gravity is near that of the plasma solids of milk (1.59), variations in citric acid content will not appreciably affect the reliability of the calculation of the total solids of milk from the specific gravity and the fat content.

Ratio of protein to ash content

The amount of protein and ash in milk, or more particularly their ratios, tend to introduce the greatest error in determining the total solids in milk from its specific gravity and fat content. The proteins have a specific gravity of about 1.35, while our data indicate a specific gravity of 5.5 for the ash constituents.

The ratio of protein to ash is usually slightly greater than 5.0. This ratio is obtained in milk with 3.5 per cent of protein and 0.70 per cent of ash, which in terms of solids corresponds to a specific gravity in milk of 1.54. If the ash is calculated to drop to 0.6, the ratio becomes 5.8 and the specific gravity values for total solids are calculated to be 0.12 per cent too low. If the ash is 0.8 the ratio becomes 4.4, and the calculated values are 0.12 per

cent too high. Actual experiments indicate that the addition of 0.10 per cent of sodium chloride renders the calculated values about 0.08 per cent too high.

The average ash content and the ratio of protein to ash of the milk from the various breeds, as obtained from the compilation of Overman, Sanmann and Wright (1) are as follows: Holstein, ash 0.681 per cent, ratio 5.0; Ayrshire, ash 0.683 per cent, ratio 5.2; Guernsey, ash 0.742 per cent, ratio 5.4; Jersey, ash 0.702 per cent, ratio 5.5; Holstein-Guernsey cross, ash 0.727 per cent, ratio 5.2; average for all breeds, ash 0.716 per cent, ratio 5.3. In the case of a few isolated samples, rather extreme ratios are reported.

Errors due to variation in protein and ash content are perhaps not so serious as one might expect, since protein and ash constituents increase together linearly with a coefficient of correlation of $0.622 \pm .009$, as shown by Overman, Sanmann and Wright.

Usually high ash milk is due to an abnormal amount of sodium chloride, which has a specific gravity in solution of 2.9, and not 5.5. A slight compensating factor present in milk samples of high sodium chloride content is the lower lactose, calcium and phosphate content. Furthermore, the milk samples with a low protein ash ratio usually contain small absolute amounts of these two constituents.

It is impossible to estimate from analytical data the error that one might expect as a result of variations in composition. In mixed milk the error probably would amount to only a few hundredths of a per cent of total solids. In the case of abnormal milk from a single cow it might be higher.

Equation applied to 421 samples

All of the comparisons made between the total solids as calculated from the specific gravity of the milk determined after cooling to 30° C., and by actual drying, have been grouped and are presented in Table 4. This table includes 287 samples of bottled market milk collected at two different seasons of the year from various cities in New York State. The remaining samples were obtained from different individual cows or are samples in which the effects of variations in fat, lactose and plasma solids were studied. Since our previous discussion has indicated that the errors in the total solids calculated from the specific gravity are at least as small as the errors obtained in determining the total solids by drying, the deviations in Table 4 can be attributed no more to errors in the determination of the total solids from the specific gravity, than to the errors in determining the total solids by actual drying of the samples.

The deviations were plotted in one case against the fat content of the samples and in the other case against the plasma solids content of the samples, but no relation was found between these components and the deviations.

In the case of the 287 samples of commercial milk, the fat as determined by the Babcock method was used in the equation for calculating the total solids from the specific gravity, the fat being expressed to the nearest 0.1 per cent.

TABLE 4

Differences between the total solids as determined by drying by the Mojonnier method and as calculated from the specific gravity and fat content. 421 samples

DEVIATIONS NOT GREATER THAN	NUMBER OF SAMPLES	PERCENTAGE OF TOTAL NUMBER
%		%
0.05	124	29.5
0.10	91	51.1
0.15	94	73.4
0.20	58	87.2
0.25	50	99.1
0.30	4	100.0
Mean error		−.011
Mean deviation		.094

The specific gravity of the milk constituents at 30° C.

The specific gravities of the plasma solids and the fat as they occur in milk were calculated by the method of least squares, from the analysis of 30 samples of whole and 30 samples of skimmed milk, by substituting the experimental values in the following equation, which expresses the relation between the variables in terms of specific volumes:

$$\frac{100}{\text{Sp. gr. milk}} = \frac{\text{Fat}}{\text{Sp. gr. fat}} + \frac{\text{Plasma solids}}{\text{Sp. gr. plasma solids}} + \frac{\text{water}}{1}$$

The results obtained are given below:

	Fat	Plasma solids
30 samples of whole milk	0.9140	1.5900
30 samples of gravity skimmilk	0.8915	1.5941
60 samples of whole and skimmilk together	0.9121	1.5930

These data indicate that fat has a specific gravity of 0.913 and the plasma solids a specific gravity of 1.592 as they exist in milk when cooled to and measured at 30° C.

Substituting the known specific volumes in a suitable equation involving the different constituents of milk, the specific gravity of the ash was calculated to be 5.5. The specific gravity of the ash constituents as estimated from the specific gravity of pure inorganic salts in solution was 3.3.

The specific gravity of the milk constituents at 30° C. as we have determined them are given in Table 5 in comparison with those given by Richmond (3).

TABLE 5

Specific gravity of the milk constituents

	SHARP AND HART AT 30° C.	RICHMOND AT 15° C.
Fat	0.913	0.93
Plasma solids	1.592	1.616
Lactose	1.63	1.666
Citric acid	1.68	(as lactose)
Protein	1.35	1.346
Ash	5.5	5.5

CONCLUSION

1. The previous temperature history of the milk influences its specific gravity at 15° C. This effect is due to variations in the physical state of the fat. The magnitude of the effect increases with the fat content.

2. The determination of the specific gravity at 30° C. after previous warming to 45° C. for one-half minute is recommended as a method which will insure that the determination is made while the fat is in the liquid state.

3. The following equation then applies for calculating the total solids from the fat content and the specific gravity:

$$\text{Total Solids} = 1.2537\ \text{Fat} + 0.2680\ \frac{\text{Lactometer}}{\text{Sp. gr. of milk}}$$

4. In 421 comparisons of the total solids as calculated by the above equation and as determined by drying, the deviation between the two values never exceeded 0.30 per cent.

5. The possibility of errors in the determination of total solids by drying is pointed out.

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AN EXPERIMENT IN CHOPPING ALFALFA HAY AT THE TIME OF STORAGE

Effect upon Space Required, Temperatures Attained, Color, Feeding Value, and Losses of Feed Constituents

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Interest in chopping hay when it is hauled from the field to be put in the mow has been stimulated recently by certain manufacturers of farm buildings and farm machinery. Farmers will want to decide sooner or later whether to chop or not to chop their hay. If a farmer is raising hay to sell or if he is making only a small quantity and does not have access to the necessary machinery, it won't be hard for him to decide not to chop his hay. On the other hand, if he is making considerable hay for his own livestock and if he has the necessary machinery, he can well afford to give serious consideration to the matter of chopping.

The principal advantages which have been claimed for chopping are that more hay can be put in a given space, the job of making hay is easier, and there is less waste in feeding. The chief disadvantages are more dust in the barn, and more care required in curing. In view of the interest that is being taken in the chopping of hay for dairy cattle and other livestock, an experiment was made to get some exact information on the value of chopping hay, although the claims presented do not appear unreasonable.

A hay barn at the National Agricultural Research Center at Beltsville, Md., was partitioned off into four compartments. Two of these to be used for chopped hay had a floor space of approximately 8 by 12 feet each; the other two to be used for long hay had a floor space of approximately 12 by 20 feet each.

First-cutting alfalfa was used. Part of the hay was mowed June 11, raked June 12, rained on the night of June 12, turned June 13, and put in the mow June 14. There was some dew on the first two or three loads. The first compartment was filled with hay run through the cutter and blown into the mow. The knives of the cutter were set for cutting ¼ inch lengths. Alternate loads, as hauled from the field, were stored in another compartment in the natural long form. Five loads weighing about 6 tons in all were stored in each of these compartments. This quantity made the depth of hay 9 feet in each compartment.

Three days later the other two compartments were filled. The hay was mowed June 16, raked the same day, and put in the mow June 17 after the dew was off. The knives of the cutter were set to cut ¾ inch lengths, instead of ¼ inch lengths, as was done in chopping hay of the first lot mowed. Four

loads, or about 5 tons, were chopped, and about the same quantity was stored in long form.

When each of the four compartments was being filled, samples of the hay placed in it were taken for chemical analysis.[1] Part of each sample was used to determine the composition of the hay at time of storage, and a similar portion was placed in a burlap bag. The bags of hay were buried at different depths in a vertical row in the center of the compartment. Those of the chopped hay were placed between each two loads, and those of the long hay were placed in the middle of each load. They were recovered three to five months later as the hay was removed from storage, and were analyzed to show the change in composition.

In each compartment a half-inch galvanized pipe was inserted at the center so that the lower end was at about the top of the first load put in. Temperatures were taken by lowering ordinary mercury thermometers into these pipes.

The hay used in the two lots was cured to about the same extent when put in storage, but none of it was quite as dry as most farmers would like to have their hay to put in the mow or stack. The finely chopped hay of the first lot had 27.02 per cent moisture and the long hay stored for comparison had 27.42 per cent. The coarsely chopped hay and the long hay of the second lot both had 25.31 per cent moisture.

METHOD OF FEEDING

Feeding of the first lot started after the hay had been in storage about 100 days. Chopped hay and long hay were fed concurrently to the two groups of Holstein cows by the single reversal method. The finely chopped hay and long hay of the first lot were fed to 8 cows, 4 in each group. Concentrates were fed liberally until the cows became accustomed to chopped hay and then in amounts judged sufficient to maintain their body weights without material gain in weight. These cows were on the experimental ration 7 days before the first 30-day feeding period began. After 30 days the two groups were reversed and the feeding continued for another 30 days.

Then the coarsely chopped hay and long hay of the second lot were fed by the same method to two groups of 3 cows each. The 7-day preliminary period was omitted because most of these cows were already accustomed to eating chopped hay.

RESULTS

Time required to store hay by each of the two methods

When the hay was chopped in ¼ inch lengths and blown into the mow, three men stored the hay at the rate of 1 ton in 14 minutes; when it was pitched into the mow by hand and stored in long form, three men required

[1] All the chemical analyses were made by C. G. Melin, Bureau of Dairy Industry.

19 minutes to unload a ton. The time required to unload a ton of long hay by using a horse-drawn hay fork or a power-driven hoist was not determined.

The mow space occupied

The mow space occupied by the hay at time of storage and when it was taken out is shown in Table 1. All the hays lost considerable weight in storage through drying out. The chopped hay settled very little. This explains why a ton of the dry chopped hay occupied more space at the time of removal than a ton of the freshly chopped hay did at the time of storage. Because of settling and a higher dry matter content, both the long and chopped hays contained more dry matter per cubic foot of storage space occupied when they were taken out than they did at the time of storage.

At the time of storage a ton of finely chopped hay occupied only 32 per cent, and a ton of coarsely chopped hay, 46 per cent, as much storage space as a ton of long hay. When taken out, a ton of the dry finely chopped hay occupied 40 per cent, and a ton of the dry coarsely chopped hay, 56 per cent, as much storage space as a ton of the dry long hay.

TABLE 1

Mow space occupied by chopped hay and long hay when put in storage and when taken out

	QUANTITY OF HAY	STORAGE SPACE PER TON	DRY MATTER		
			Per cent	Per ton	Per cubic foot
	Tons	*Cubic feet*		*Pounds*	*Pounds*
First lot of hay					
Finely chopped hay:					
Hay put in storage	6.09	152	72.98	1459.6	9.60
Hay removed from storage	4.62	164	89.90	1798.0	10.96
Long hay:					
Hay put in storage	5.90	475	72.58	1451.6	3.06
Hay removed from storage	4.54	412	90.55	1811.0	4.40
Second lot of hay					
Coarsely chopped hay:					
Hay put in storage	5.02	218	74.69	1493.8	6.85
Hay removed from storage	3.94	229	92.07	1841.4	8.04
Long hay:					
Hay put in storage	5.16	475	74.69	1493.8	3.14
Hay removed from storage	4.06	412	91.52	1830.4	4.44

The maximum temperature attained

The finely chopped hay reached a high temperature of 151° F. in 9 days and after 3 months the temperature was still about 100° F. Some spots developed a maximum temperature of 190° F. The coarsely chopped hay

reached a maximum temperature of 128° F. in 19 days, and in 2 months the temperature had decreased to that of the air. The long hay of the first lot reached a temperature of 122° F. in 4 days, and that of the second lot 120° F. in 1 day. In 3 weeks the temperature of both was down to about that of the air.

The influence of the method of storage upon the carotene content

When the first lot of hay was stored in the mow, the finely chopped hay and the long hay each had a carotene content of 46 parts per million on a dry-matter basis; when the hay was removed, the carotene content of the finely chopped hay was only 0.9 part per million of dry matter, or practically nothing; and that of the long hay was 2.9, which was a little better but still very low. The coarsely chopped hay and the long hay of the second lot each showed a carotene content of 74 parts per million of dry matter at the time of storage. When these hays were removed, the carotene content of the coarsely chopped hay was 3.8, and that of the long hay was 4.9.

The effect upon the color[2]

When removed from storage, the finely chopped hay varied in color from brown to black; the coarsely chopped hay was a lighter brown, but in neither lot of chopped hay was there any green color whatever. The long hay of the first lot had from 1 to 25 per cent as much green color as the greenest grade of alfalfa hay, and the long hay of the second lot had from 14 to 45 per cent as much. The latter hay, however, had more green color at the time of storage than the long hay of the first lot because it had cured in the field more quickly and had not been wet with rain. The color of the long hay in the first lot was best at the center of the compartment, and the color of the second lot was best near the top.

Influence on the losses of weight and of dry matter

The weights of the different lots of hays and of the dry matter the hays contained at the time they were stored, the weights at the time of removal from storage, and the losses in weight and dry matter during storage are shown in Table 2. The finely chopped hay lost 6.5 per cent dry matter, the coarsely chopped hay 3.2 per cent, and the long hays of the first and second lots 4.1 and 3.5 per cent, respectively. In view of the high temperatures attained by the finely chopped hay and the length of time the high temperatures persisted, the 6.5 per cent loss of dry matter appears very moderate.

[2] Color determinations were made by Carl F. Welsh, Bureau of Agricultural Economics.

TABLE 2

Weights of hay and dry matter put in storage, the weights taken out, and the losses in weights and dry matter

	FIRST LOT OF HAY		SECOND LOT OF HAY	
	Finely chopped hay	Long hay	Coarsely chopped hay	Long hay
Weight of hay stored ..... pounds	12,175	11,810	10,040	10,315
Weight of hay when removed ..... pounds	9,245	9,078	7,882	8,125
Loss in weight during storage ..... pounds	2,930	2,732	2,158	2,190
Loss in weight during storage ..... per cent	24.1	23.1	21.5	21.2
Moisture content of hay stored ..... per cent	27.02	27.42	25.31	25.31
Moisture content of hay removed ..... per cent	10.10	9.45	7.93	8.48
Dry matter in the hay stored ..... pounds	8,885	8,572	7,499	7,704
Dry matter in the hay removed ..... pounds	8,311	8,220	7,257	7,436
Loss of dry matter ..... pounds	574	352	242	268
Loss of dry matter ..... per cent	6.5	4.1	3.2	3.5

The analyses were applied to the weights given in Table 1 and it was found that by far the greatest part of the dry matter loss was in the nitrogen-free extract. There appeared to be no loss of either protein or fiber, and no great loss of ether extract. The data presented do not, of course, include the losses that occurred between the time of mowing and storing.

The effect upon the feeding value

Palatability.—The cows at first were reluctant to eat the black finely chopped hay. In order to induce them to eat more of the black chopped hay, concentrates were mixed with the chopped hay and equivalent amounts given the group on long hay. This explains why such liberal quantities of concentrates were fed in the first 30-day period of the experiment. After the cows became accustomed to the black hay, they ate as much of it as the other group ate of the long hay. The hay that was brown instead of black was generally consumed in slightly larger amounts than was the long hay. This was the case whether the hay was finely chopped or coarsely chopped.

Quantities of hay eaten.—Enough hay was fed each cow every day so that there was nearly always a small amount refused. The highest quantity refused by a group in any 30-day period was 10 per cent, and the lowest was 7 per cent. Feeding the hay in this way made it impossible to estimate the quantity which would have been wasted if the cows had been fed equal quantities. The smallest average quantity of hay consumed per cow per day by any group for a 30-day period was 26.4 pounds, and this was by group No. 1, fed finely chopped black hay in the first period; the highest was 34.2 pounds by group No. 3, fed coarsely chopped hay in the first period on that lot of hay.

Production.—The total quantity of milk and quantity of butterfat produced was a little more when the cows were fed the long hay. This was the

TABLE 3

Summary of feed eaten, production of milk and butterfat, and body weights

	TOTAL FEEDS EATEN BY GROUP			TOTAL PRODUCTION OF GROUP		DECLINE IN MILK PRODUCTION	BODY WEIGHT	
	Concentrates	Hay	Total digestible nutrients	Milk	Butterfat		Average per cow	Gain or loss per cow
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Per cent*	*Pounds*	*Pounds*
First lot of hay								
Finely chopped hay:								
First 30-day period (Group 1)	1,374	3,166	2,667	3,258.0	102.83	22.6	1,163	+104
Second 30-day period (Group 2)	571	4,036	2,466	3,159.8	102.90	24.3	1,255	−4
Total	1,945	7,202	5,133	6,417.8	205.73	[1]23.4		[1]+50
Long hay:								
First 30-day period (Group 2)	1,354	3,327	2,658	3,909.7	122.92	+0.1	1,215	+107
Second 30-day period (Group 1)	376	3,822	2,204	2,718.2	86.37	18.0	1,176	−11
Total	1,730	7,149	4,862	6,627.9	209.29	[1]8.9		[1]+48
Second lot of hay								
Coarsely chopped hay:								
First 30-day period (Group 3)	283	3,076	1,830	2,243.5	75.66	10.8	1,285	+38
Second 30-day period (Group 4)	239	2,644	1,556	2,101.4	71.31	[1]19.3	*1,223	(**)
Total	522	5,720	3,386	4,344.9	146.97	[1]15.0		
Long hay:								
First 30-day period (Group 4)	336	2,811	1,703	2,470.4	81.27	+1.1	1,231	+37
Second 30-day period (Group 3)	184	2,809	1,593	1,988.7	65.98	18.4	*1,268	(**)
Total	520	5,620	3,296	4,459.1	147.25	[1]8.6		

[1] Average for 30-day period.

* Estimated.

** Final weights were not taken because three of the six cows in Groups 3 and 4 were in quarantine.

case whether finely chopped or coarsely chopped hay was fed in comparison with the long hay. Although Table 3 shows that the difference in the total production of the cows when fed chopped hay and long hay was rather small, there is no doubt that if the continuous instead of the reversal method had been used in conducting this experiment, the differences would have been somewhat greater and more favorable to the long hay. Moreover, in this connection it should be observed that when the cows were fed the long hay they consumed less digestible nutrients than when they were fed the chopped hay.

The average rate of decline in milk production of the four groups by 30-day periods is shown in Table 3. The percentage decline was calculated from the first 3 days and the last 3 days of each 30-day period. The decline

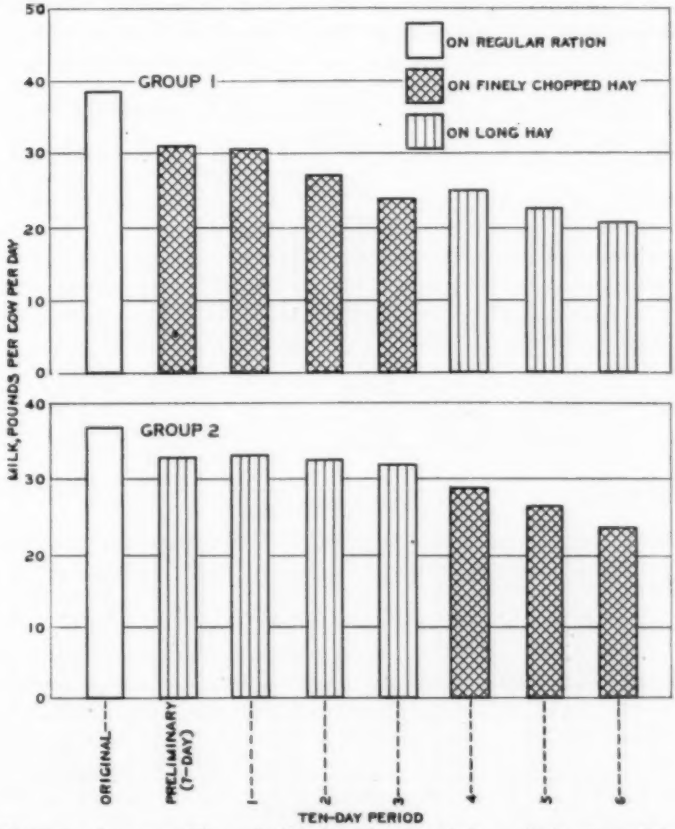

CHART 1. Average milk production by 10-day periods on finely chopped hay and long hay of the first lot.

for the periods when long hay was fed are not far from normal, being 8.9 per cent for the first lot of hay and 8.6 per cent for the second lot of hay during the two 30-day periods on each hay. When the finely chopped hay was fed, the average decline in milk production for the two 30-day periods was 23.4 per cent and that of the cows on coarsely chopped hay was 15.0 per cent.

Chart 1 shows the declines in milk production per cow per day for the two groups on finely chopped hay and long hay of the first lot, by 10-day periods, beginning with the 10 days on the regular ration before the experiment started. The chopped hay fed at first was very dark in color. Both groups declined sharply in milk production during a 7-day preliminary period, but the yield of the cows fed the finely chopped hay fell off more than that of the cows on long hay. Thereafter the production of both groups was sustained better than at first. This chart shows that when the cows

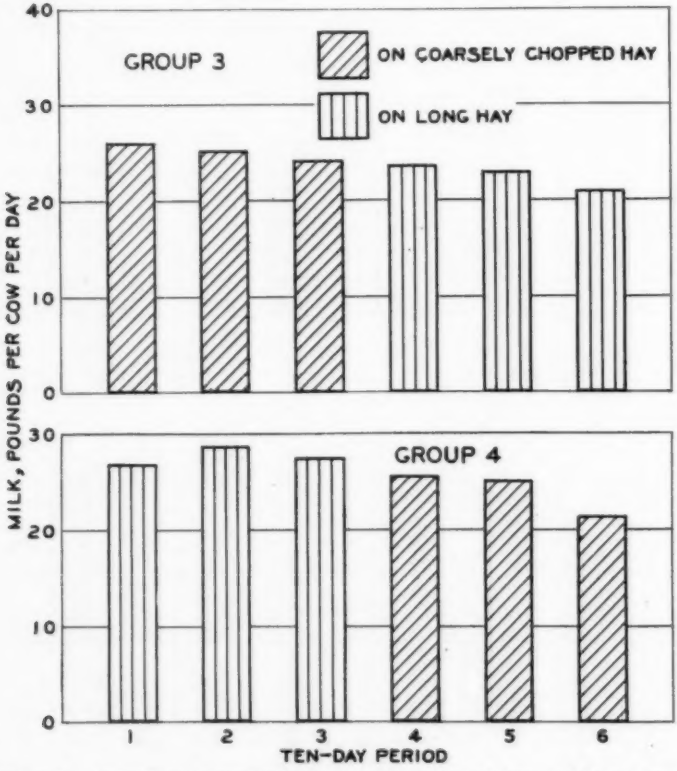

CHART 2. Average milk production on coarsely chopped hay and long hay of the second lot.

were on long hay they maintained their production better than when fed the finely chopped hay. Chart 2 gives a similar comparison for the two groups fed coarsely chopped and long hay of the second lot. The coarsely chopped hay maintained production better than the finely chopped hay, but was not as good for milk production as the long hay.

The difference in milk production for the last 10 days previous to a change in hay feeding as compared with the first 10-day period after the change, as shown in Charts 1 and 2, also favors the long hay. When the kind of hay fed was changed at the end of the first 30-day period from finely chopped to long hay, the average daily milk production per cow increased from 23.9 pounds to 24.9 pounds. When the change was made from the long hay to the finely chopped hay, the milk declined from 32.0 pounds to 28.9 pounds. Similar figures for the second part of the experiment, in which coarsely chopped and long hay were compared, did not show such pronounced differences, although the advantage was still with the long hay. When feeding was changed from the coarsely chopped hay to long hay, the milk yield per day per cow declined from 23.9 to 23.2 pounds, and when it was changed from long to coarsely chopped hay, the yield declined from 27.5 to 25.4 pounds.

Body weights.—During the 7-day preliminary period after groups 1 and 2 were taken off the original ration, all of the cows in both these groups lost weight, with the result that they were somewhat gaunt when the experiment proper started. This will explain the large gains made in body weight (Table 3) during the first 30-day period by both of these groups. The final weights of groups 3 and 4 on coarsely chopped and long hay were not taken, because 3 of the 6 cows were quarantined during the last week of the experiment. The other weights given show that both groups gained or lost at about the same rate, indicating that the level of feeding was much the same for the groups being compared.

SUMMARY

Running the hay through a cutter and blowing it into the mow was easier than storing it in a long condition, mainly because the hand work in the mow was saved.

Two or three times as much hay could be put in a given space in the chopped form as in the natural long form.

The chopped hay heated more than the long hay, and the finely chopped hay heated more than the coarsely chopped hay.

Neither the carotene nor the green color was so well preserved in the chopped hay as in the long hay.

The loss of dry matter during storage was higher in the finely chopped hay than in the coarsely chopped hay or in the long hay, but the greatest loss observed in this experiment was still quite moderate.

The black chopped hay was not so palatable as the long hay, but the brown chopped hay was fully as palatable as the long hay.

The quantities of milk produced and the maintenance of the milk flow were in favor of the cows fed the long hay, and this was the case in spite of their slightly lower consumption of nutrients as estimated from actual analyses and the coefficients of digestion given by Henry and Morrison.

This investigation was with hay containing 25 to 27 per cent of moisture at time of storage, or a little higher than is usually considered desirable. The results with hay containing more moisture or less moisture might be somewhat different from those reported.

A COMPARISON OF PRESSURE AND CENTRIFUGAL HOMOGENIZATION OF ICE CREAM MIXES

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The improvement in body, texture, and quality of ice cream prepared from pressure homogenized ice cream mixes as compared to unhomogenized mixes is universally recognized. However, there appears to be no data in the literature comparing physical properties of ice cream mixes, and the quality of the ice cream prepared from them, when the mixes are homogenized with pressure and with centrifugal homogenization. The desirability of such experimental data seemed to warrant a study of this problem.

EXPERIMENTAL

Ice cream mixes for these experiments, with the exception of two later tests, were standardized to contain 12 per cent fat, 10 per cent milk-solids-not-fat and 14 per cent sugar. Cream, skimmilk and skimmilk powder were the dairy products used in preparing these mixes. They were pasteurized at 68.0° to 71.0° C. (155° to 160° F.) for ½ hour and in some tests at 150° F. and homogenized and run through the centrifugal colloidal mill at pasteurization temperatures. A Manton-Gaulin homogenizer of 60 gallons per hour capacity with the two-stage valve was used for pressure homogenization of the mixes. A colloidal[1] mill of 100 gallons per hour capacity was used for the centrifugal homogenization of the mixes. After some preliminary trials with varying clearances of the metal surfaces of the mill the smallest possible clearance of 0.002 of an inch was used for all of the experiments. The 3-inch rotor of the mill revolved at 1700 R.P.M. The mixes were cooled over a surface tabular cooler to 4.4° C. (40° F.)

The viscosity determinations were made with the MacMichael viscometer using the disc bob. The viscosity was measured at 4.4° C. (40° F.). No endeavor was made to secure separate values for plasticity and viscosity.

In the first 3 experiments a motor driven stirrer as described by Whitaker (3) was used to thoroughly agitate the mixes to secure basic viscosity. The mixes were agitated for twenty minutes with the stirrer made of one-fourth inch wire screening, revolving at 500 to 600 revolutions per minute.

The fat globules were measured at a magnification of approximately 2000 diameters using an ocular micrometer disc standardized with the microscope so adjusted that each of the smallest marks represented one

[1] The colloidal mill was loaned to us by the Premier Mill Corporation of Geneva, New York.

Approved by the Director of the New York Agricultural Experiment Station as Journal Paper No. 164, June 15, 1936.

TABLE 1

Viscosity in centipoises and size of fat globules and fat globule clumps of pressure and centrifugal homogenized ice cream mixes

TREATMENT	AGING PERIOD										AV. SIZE OF FAT GLOBULES	NO. OF CLUMPS	AV. SIZE OF FAT GLOBULE CLUMPS
	3/4 hr.		2 hrs.		4 hrs.	8 hrs.	24 hrs.		48 hrs.				
	Not agitated	Agitated	Not agitated	Agitated	Not agitated	Not agitated	Not agitated	Agitated	Not agitated	Agitated			
	cp.	*cp.*	*cp.*	*cp.*	*cp.*	*cp.*	*cp.*	*cp.*	*cp.*	*cp.*	*microns*		*microns*
Experiment 1—2000–500 pounds pressure													
H	16.8	15.8			16.5	16.5	16.2	15.8	16.5	15.8	1.61	43	1.58 × .79
C	14.5	14.5			13.8	15.0	15.0	13.0	15.4	14.2	2.06	0	
Hg	33.5	41.0			88.0	123.8	179.8	55.3	235.8	54.2			
Cg	33.9	37.5			82.0	119.0	170.0	50.0	192.0	48.3			
Experiment 2—1200–400 pounds pressure													
Hg	30.5	33.8	89.7	40.5			228.1	64.5	289.0		1.65	36	2.36 × 1.08
Cg	33.8	30.0	87.0	44.0			218.0	53.5	243.0		2.10	0	
											1.74*	0	
Experiment 3—900–300 pounds pressure													
H	14.5		15.0		16.5		15.0	14.9	15.0		1.96	23	2.26 × 1.13
C	13.4		13.8		15.0		13.8	13.0	13.4		1.89*	0	
Hg	36.8		102.3	46.2	189.0		346.0	56.0	328.7				
Cg	34.2		103.5	41.0	165.3		282.0	55.0	296.4				

H = pressure homogenization with homogenizer without gelatin.

C = centrifugal homogenization with colloidal mill without gelatin.

Hg = same as H plus gelatin.

Cg = same as C plus gelatin.

* = run through colloidal mill 3 times.

micron. One-half cubic centimeter of the mix to be examined was diluted with 100 cc. of distilled water and mounted as a hanging drop preparation. Two hundred fat globules and the clumps found in the fields were measured for each mix processed except for some of the last experiments in which the clumps predominated and two hundred clumps were measured.

RESULTS

In the first series of experiments various two-stage homogenization pressures were used and an endeavor was made to determine what homogenization pressure would produce mixes and the ice cream prepared from them of similar properties to centrifugal homogenized mixes and ice cream. The results of the first experiments on three different mixes comparing their properties when processed by pressure and centrifugal homogenization, with a colloidal mill, are given in Table 1. The homogenization pressures for Experiments 1, 2 and 3 are 2000, 1200 and 900 pounds on the first stage and 500, 400, and 300 on the second stage, respectively.

As can be seen from this table, the ice cream mixes processed with the two-stage homogenizer were only a trifle more viscous than the centrifugal colloidal mill mixes. These mixes without gelatin were low in viscosity and showed no consistent increase in viscosity at aging periods of ¾ of an hour, 2, 4, 8, 24 and 48 hours. Agitation of these mixes prior to viscosity determinations had no appreciable effect on their viscosity. A little heat sometimes generated from friction in the agitation unit, caused a slight increase in the temperature of the mixes, which might account for slight decreases in their viscosity. Similar results were previously obtained by the author (2) when single-stage homogenized ice cream mixes were re-homogenized several times at 200 pounds pressure. Agitation did not reduce the viscosity of these mixes.

The mixes containing gelatin increased in viscosity throughout the 48-hour aging period. Agitation, as can be seen in Table 1, greatly decreased the viscosity of aged mixes due to the breaking up of the gel formation. When mixes in Experiment 1, containing gelatin, were agitated after 2 to 5 hours aging, they were practically as viscous in 24 hours as the same mixes which had not been agitated. However, when the homogenized and colloidal mill mixes containing gelatin in Experiment 1 were agitated after 48 hours aging their viscosity as shown in Table 1 was reduced to 54.2 and 48.3 centipoises, respectively, and after 24 hours these agitated mixes increased to 107.8 and 89.0 centipoises, which was about half the viscosity of the unagitated 48-hour aged mix.

In these first trials, given in Table 1, an endeavor was made to homogenize the mixes so that the fat globules in the pressure homogenized mixes would be approximately the same size as the fat globules in the centrifugal homogenized mixes. In Experiment 1 the fat globules of the pressure homogenized mixes were smaller than those of the centrifugal homogenized

mixes. In Experiments 2 and 3, in which the homogenization pressures were reduced to 1200 and 900 on the first stage and 400 and 300 on the second stage and the mix put through the colloidal mill 3 times, the fat globules of the pressure and centrifugal homogenized mixes averaged approximately the same size.

There was no clumping of the fat globules when the mixes were homogenized in the colloidal mill. The fat globule clumps in the pressure homogenized mixes increased in size and decreased in number as the pressures were reduced as can be seen from Experiments 1, 2 and 3, Table 1.

These mixes containing 0.5 per cent of a medium grade gelatin were frozen in a Miller 40-quart horizontal brine freezer. The mix in Experiment 1 (Table 1) homogenized with 2000 pounds pressure on the first stage and 500 on the second stage froze and whipped in about one minute less time than the centrifugal mix. The mixes in Experiments 2 and 3 homogenized at lower pressures froze and whipped in exactly the same time as the colloidal mill mixes. In Experiment 1 the ice cream from the pressure homogenized mix was a trifle smoother and firmer in body than the ice cream from the centrifugal homogenized mix. In Experiments 2 and 3 with lower homogenization pressures the ice creams prepared from mixes processed by the two methods were practically the same in body and texture and they were all a little coarse.

The ice creams prepared from the mixes homogenized in the centrifugal colloidal mill did not melt down as well as the ice creams prepared from pressure homogenized mixes due to churned fat particles forming a little framework which prevented a complete melting down of the ice cream.

The experiment reported in Table 1 was repeated comparing the same homogenization pressures of 2000–500, 1200–400, and 900–300 and centrifugal homogenization on a single mix in place of 3 different mixes. The results of this test are not given in table form since they were for all practical purposes the same as in the three preceding experiments.

The results of these first experiments indicated the desirability of comparing the properties of mixes processed with a series of two-stage homogenization pressures, with centrifugal homogenization and no homogenization. Ice cream mixes were homogenized with pressures on the first stage ranging from 4000 to 1000 pounds, decreasing at 500 pound intervals, with a constant pressure of 500 pounds on the second stage, and with 500 pounds on the first stage, with no pressure on the second stage, and with the centrifugal colloidal mill. These mixes were prepared and frozen without gelatin in order to limit the effects to pressure and centrifugal homogenization.

The results given in Table 2 are the average of results obtained for three mixes of the same composition prepared and processed at successive intervals. Each ice cream mix was subjected to the complete series of pressures and centrifugal homogenization. As in previous results there

TABLE 2

Viscosity in centipoises and size of fat globules and fat globule clumps of pressure and centrifugal homogenized ice cream mixes prepared without gelatin

PRESSURE	AGING PERIOD				AV. SIZE OF FAT GLOBULES	NO. OF CLUMPS	AV. SIZE OF CLUMPS
	2 hrs.	4 hrs.	24 hrs.	48 hrs.			
	cp.	*cp.*	*cp.*	*cp.*	*microns*		*microns*
4000–500	22.0	21.6	21.8	21.6	.93	109	1.63 × .84
3000–500	20.2	19.8	20.6	20.8	1.05	85	1.52 × .77
2500–500	18.4	18.0	18.6	19.2	1.08	63	1.38 × .57
2000–500	17.0	17.1	17.9	18.0	1.29	33	1.46 × .72
1500–500	16.0	16.4	16.7	16.9	1.43	31	1.54 × .77
1000–500	15.5	15.5	15.8	15.7	1.53	39	1.74 × .83
500 –0	15.8	15.7	15.9	15.8	1.97	39	1.99 × 1.02
0	14.6	14.6	14.8	14.5	3.65	0	0
Colloidal Mill	13.6	13.5	13.8	14.0	1.81	0	0

was no consistent increase in viscosity for the 2-, 4-, 24- and 48-hour aging periods. There was a gradual decrease in the viscosity of each mix processed at pressures on the first stage ranging from 4000 pounds to zero, with the centrifugal homogenized mix a little less viscous than the unhomogenized mix. There were only 7 centipoises decrease in viscosity of the mix from 4000 pounds to zero pressure. The fat globules showed a slight increase in size from 4000 to 2500 pounds pressure with greater increases at each succeeding reduction in pressure. The number of fat globule clumps was greatest at the two-stage pressure of 4000–500 pounds. The size of the fat globule clumps did not vary much until the 1000 first stage, 500 second stage and 500 first stage pressures were reached when some increase in the size of clumps was noted.

The results of the viscosity determinations for the series of pressures at 2- and 24-hour aging periods and the size of the fat globules are shown in graph form in Figure 1. As can be seen from this figure the curves for the 2- and 24-hour aging periods run practically parallel and are very close together. The curve representing the size of fat globules shows a very gradual change from 4000 to 2500 pounds pressure with greater increases at the lower pressures.

The ice creams prepared from these mixes homogenized at the series of pressures given in Table 2 were frozen in one gallon experimental freezers. The results of the texture scores are shown in graph form in Figure 2. As can be seen from this figure the texture and body of the ice creams were good at the higher pressures of 4000 and 3000 pounds with the first evidence of coarseness at the 2500 pounds pressure. The ice creams at the lower pressures were coarse with an increase in the degree of coarseness to zero pressure. The ice creams prepared from the centrifugal colloidal mill mixes appeared to be a trifle coarser than the ice cream prepared from the unhomogenized mixes.

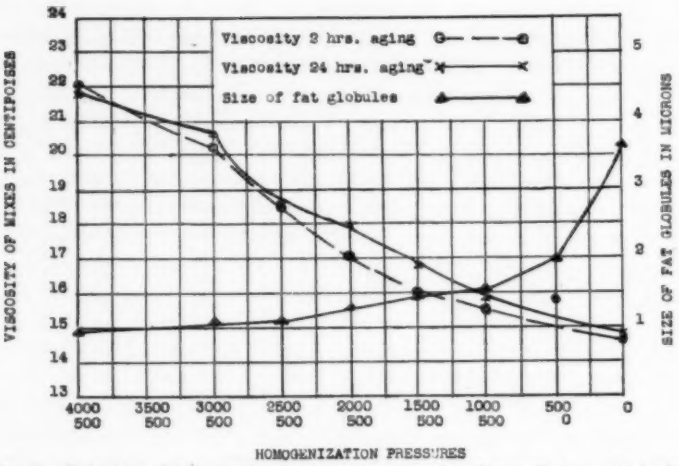

FIG. 1. Relation of homogenization pressures to viscosity and size of fat globules of ice cream mixes.

The alcohol test as suggested by Doan (1) was used to determine the stability of these mixes processed at two stage pressures of 4000 to 1000 on the first stage with a constant pressure of 500 on the second stage and with no pressure and processed with the colloidal mill. Mixtures of 4 cc. of water and 6 cc. of alcohol gave no coagulation in 5 cc. of mix with pressures ranging from 2000 to 4000 pounds on the first stage with a constant pressure of 500 pounds on the second stage but a mixture of 3 cc. of water and 7 cc. of alcohol did give a coagulation in mixes processed at the above pressures. In unprocessed mixes and those processed at the lower range of pressures and with the colloidal mill it required mixtures of 2 cc. of water and 8 cc. of alcohol to coagulate them. The unhomogenized mixes and those homo-

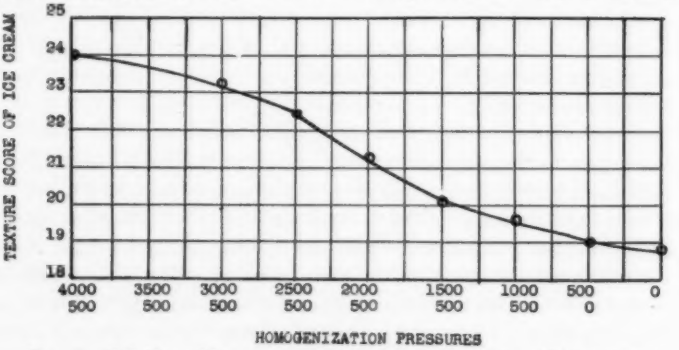

FIG. 2. Relation of homogenization pressures to texture of ice cream.

genized at low pressures and with the colloidal mill were a little more stable to the alcohol test than those homogenized at higher pressures.

To complete the pressure comparisons of two-stage homogenization, ice cream mixes prepared without gelatin containing 12 and 16 per cent fat were homogenized with a constant pressure of 2500 pounds on the first stage and the pressure on the second stage decreased from 2000 pounds to 500 pounds at 500 pound intervals and mixes without gelatin containing 12 per cent fat were homogenized with a constant pressure of 3500 pounds on the first stage and with pressures ranging from 3000 to 500 pounds at 500 pound intervals on the second stage. The viscosity, fat globules and fat globule clump measurements given in Table 3 for the 3 experiments are

TABLE 3

Viscosity in centipoises and size of fat globules and fat globule clumps of pressure homogenized ice cream mixes containing 12 and 16 per cent milk fat prepared without gelatin

PRESSURE	AGING PERIOD				AV. SIZE OF FAT GLOBULES	AV. SIZE OF FAT GLOBULE CLUMPS
	2 hrs.	4 hrs.	24 hrs.	48 hrs.		
	cp.	*cp.*	*cp.*	*cp.*	*microns*	*microns*
			12 per cent fat			
2500–2000	23.7	23.6	24.5	26.8	1.45	2.18 × 1.10
2500–1500	16.8	17.0	17.4	18.2	1.31	1.67 × .85
2500–1000	16.3	16.2	16.8	17.8	1.19	1.76 × .95
2500– 500	16.8	16.9	17.6	18.4	1.16	1.69 × .90
0	12.5	12.5	12.8	13.1	3.78	
			16 per cent fat			
2500–2000	103.6	100.4	116.4	118.8	1.20	2.81 × 1.59
2500–1500	42.1	43.0	44.6	46.0	1.13	2.42 × 1.31
2500–1000	32.0	32.1	33.5	33.6	1.22	2.15 × 1.18
2500– 500	28.8	29.4	30.4	30.2	1.20	2.09 × 1.15
			12 per cent fat			
3500–3000	41.4	38.6	43.9	43.9	1.07	2.19 × 1.20
3500–2500	25.6	25.8	27.3	27.3	.96	1.83 × .92
3500–2000	19.7	19.8	20.4	20.7	.84	1.48 × .73
3500–1500	18.6	19.1	24.6	19.9	.91	1.59 × .77
3500–1000	17.6	18.0	18.7	18.9	.80	1.53 × .71
3500– 500	18.1	18.6	19.0	19.6	.81	1.58 × .77

the average of determinations made on two ice cream mixes of the same composition prepared at successive intervals and processed at the pressures given in the table.

When ice cream mixes prepared without gelatin were homogenized with a constant pressure of 2500 pounds on the first stage and the pressure on the second stage was decreased from 2000 to 500 pounds at 500 pound intervals, the 2500 first-stage and 2000 pound second-stage pressure mixes were more viscous, contained larger fat globule clumps and whipped a little

less readily than the mixes with a greater difference in pressure between the first and second stage. The body and texture of the ice creams prepared from these mixes were similar.

Using the same pressures and increasing the percentage of fat gave similar results. The higher fat content made the effect more pronounced.

Other tests using a pressure of 3500 pounds on the first stage and pressures ranging from 3000 to 500 pounds at 500 pound intervals on the second stage gave the same general results.

SUMMARY

The two-stage homogenization of ice cream mixes at low pressures produced mixes which were similar in viscosity and size of fat globules to mixes processed with the centrifugal colloidal mill, except that the colloidal mill ice cream mixes contain no fat globule clumps. The ice creams prepared from these mixes containing gelatin were likewise similar in body and texture.

When ice cream mixes prepared without gelatin were homogenized with pressures on the first stage ranging from 4000 to 1000 pounds, decreasing at 500 pound intervals with a constant pressure of 500 pounds on the second stage, they showed a gradual decrease in viscosity from 4000 pounds to zero pressure. The colloidal mill mixes were a little less viscous than the unhomogenized mixes. The fat globules showed a slight increase in size from 4000 to 2500 pounds pressure with greater increases at each succeeding reduction in pressure.

The texture and quality of the ice creams were good at the higher pressures with a trace of coarseness at the 2500 pounds pressure. The ice creams prepared from mixes processed at the lower pressures were coarse and the centrifugal colloidal mill ice cream was a trifle coarser than the unhomogenized ice cream.

When ice cream mixes prepared without gelatin were homogenized with a constant pressure of 2500 pounds on the first stage and the pressure on the second stage was decreased from 2000 to 500 pounds at 500 pound intervals, the 2500 first-stage and 2000 pound second-stage pressure mixes were more viscous, contained larger fat globule clumps and whipped a little less readily than the mixes with a greater difference in pressure between the first and second stage. The body and texture of the ice creams prepared from these mixes were similar.

REFERENCES

(1) Doan, F. J. The relation of feathering and heat stability of cream to fat clumping produced by homogenization. Jour. Dairy Sci. **14**: 527–539. 1931.

(2) Hening, J. C. Some observations on the basic viscosity of ice cream mixes. Jour. Dairy Sci. **14**: 84–92. 1931.

(3) Whitaker, R. A device for reducing an ice cream mix to its basic viscosity. Jour. Dairy Sci. **12**: 285–287. 1929.

THE THIRTY-FIRST ANNUAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

R. B. STOLTZ
Secretary-Treasurer

On June 15 to 19, inclusive, 1936, the American Dairy Science Association convened at State College, Pennsylvania, for their thirty-first annual meeting. The program, given in the June issue of the JOURNAL OF DAIRY SCIENCE, was arranged by the program committee headed by S. I. Bechdel. The July issue of the JOURNAL contains the abstracts of the various papers presented.

This is the first year that a registration fee has been charged. A fee of $1.00 was charged the members, a fee of $2.00 was charged the non-members, and there was no registration fee for ladies and children.

There was a large attendance at the meeting, 35 states of the 48 as well as Canada and Australia being represented. 292 of the 362 registrants were members. 135 ladies and 102 children made the total attendance 599. The registration by states was furnished by M. A. Farrell.

In the last few years there has been a noticeable increase in the bringing of the entire family to the meetings; thus the ladies and children are coming to feel that the meeting is an annual one for them as well as for the men.

Tuesday evening was the first social get-to-gether. The families, members, and guests met in the second floor lounge of Old Main, renewing friendships made at previous meetings and making new acquaintances.

With the compliments of the Cherry-Burrell Corporation, a mountain tour for the wives, young folks, and children of registrants was planned for Wednesday. Wednesday evening there were two dinners given, the Creamery Package Manufacturing Company being host.

Thursday morning the children had their play supervised at the Municipal Playground or were taken on a mountain hike. At this time the ladies visited places of interest on the campus or played golf. Thursday afternoon the children and young people went to Glennland Pool where they spent the time swimming and playing. During this period the ladies were entertained at the lovely Nittany Lion Inn. The annual banquet was held Thursday night at McAllister Hall. Later in the evening there was dancing in the Old Main, the music being furnished by a campus orchestra.

OPENING SESSION

The opening session of the Association was called to order by President, H. A. Ruehe, at 7:30 P.M. Tuesday evening, June 16, 1936, in the College Auditorium.

Registration by states

COUNTRIES OR STATES	REGISTRANTS		WOMEN	CHILDREN	TOTAL
	Members	Non-members			
Australia	—	1	1	—	2
Canada	4	1	2	2	9
California	1	—	—	—	1
Colorado	—	1	1	—	2
Connecticut	7	—	3	—	10
Delaware	—	1	—	—	1
Dist. of Columbia	25	3	10	11	49
Florida	1	—	—	—	1
Idaho	1	—	—	—	1
Illinois	17	5	12	8	42
Indiana	6	—	3	1	10
Iowa	8	—	4	—	12
Kansas	5	1	—	—	6
Kentucky	5	—	1	2	8
Louisiana	1	—	—	—	1
Maine	—	2	—	—	2
Maryland	6	2	2	2	12
Massachusetts	10	—	1	—	11
Michigan	12	—	3	5	20
Minnesota	6	—	5	1	12
Missouri	8	2	5	4	19
Montana	1	—	—	—	1
Nebraska	6	—	3	2	11
New Hampshire	4	3	—	—	7
New Mexico	1	—	—	—	1
New Jersey	16	3	2	—	21
New York	40	10	17	6	73
North Carolina	4	—	3	3	10
Ohio	17	3	12	9	41
Oklahoma	3	—	—	—	3
Pennsylvania	41	26	30	34	131
South Dakota	1	—	—	—	1
Tennessee	1	—	—	—	1
Texas	1	—	1	—	2
Vermont	8	1	7	8	24
West Virginia	8	1	3	12	24
Wisconsin	12	2	3	4	21
	294	68	135	102	603

R. D. Hetzel, president of Pennsylvania State College, gave the welcoming address.

H. A. Ruehe, president of the American Dairy Science Association, then gave an address covering the following:

Thanking President Hetzel for his kind words of welcome, Dr. Ruehe also expressed his pleasure in having the opportunity of being at Penn-

sylvania State College. He then gave a brief history of the Association stressing its founding, its scientific growth, and its position today.

Unlike a decade ago, now science and agriculture and dairying are working closely together; and research in these fields should be practical as well as theoretical.

Dr. Ruehe then spoke of the JOURNAL OF DAIRY SCIENCE, of its growth and the recent addition of the abstracts. He thanked those who had given so generously of their time and talent and urged every member to aid in increasing the circulation.

The President then expressed the desire of the officers to render the best service possible to the membership of the Association and the dairy industry.

Thanking our hosts for the instruction and inspiration so generously offered, Dr. Ruehe closed his address.

SECRETARY-TREASURER'S REPORT

Membership

The problem of increasing our membership is one of the most important problems that the Association has to face. The dairy industry should furnish at least 1,000 members for our Association. The leaders of the dairy industry are becoming professional men. Those men, who are college trained, should consider themselves as professionals. This will necessitate their being associated with a scientific organization as well as being kept posted on the latest scientific work in the dairy field. Our Association publishes the JOURNAL OF DAIRY SCIENCE to furnish the latter.

This year we have increased the cost of the publication by the addition of printing the abstracts.

For the past three years we have put on a membership campaign and have increased our membership each year, but our serious problem is that more than half of the number of members we have added to our membership list are lost by lapsing. Our problem then is to not only get new members, but to hold a greater percentage of the members which we now have. Following is a list of members, old and new by States:

STATE	OLD	NEW	STATE	OLD	NEW
Albama	2	2	Kentucky	5	—
Arizona	2	2	Louisiana	2	6
Arkansas	1	—	Maine	2	3
California	36	48	Maryland	12	4
Colorado	1	3	Massachusetts	15	8
Connecticut	16	10	Michigan	21	6
Delaware	—	—	Minnesota	32	3
Dist. of Columbia	22	11	Mississippi	3	—
Florida	5	1	Missouri	19	2
Georgia	3	2	Montana	5	1
Idaho	4	—	Nebraska	9	1
Illinois	48	25	Nevada	1	—
Indiana	17	—	New Hampshire	5	—
Iowa	16	4	New Jersey	10	7
Kansas	8	—	New Mexico	3	3

New York	70	16	Texas	5	3
North Carolina	4	2	Utah	5	—
North Dakota	3	—	Vermont	9	2
Ohio	45	27	Virginia	7	1
Oklahoma	7	1	Washington	17	3
Oregon	7	1	West Virginia	8	1
Pennsylvania	37	24	Wisconsin	33	4
Rhode Island	—	—	Wyoming	1	1
South Carolina	4	1	Canada	13	4
South Dakota	3	2	Foreign	11	5
Tennessee	4	5			
			Total	617	215

Credit is given not by the membership committee who obtains the new members, but the state is credited where the new member is located. This shows that we had a membership of 734 last year. On July 16 of this year we have taken in 215 new members, and had 117 members lapse. It is our desire to interest at least one-half of the lapsed membership to renew this year and to increase our new members, so that our total membership at the end of this year will be not less than 800.

GENERAL BUSINESS SESSION

Friday, Morning

8 to 9 A.M., June 19, 1936

College Auditorium, Central Campus

O. F. Hunziker, Chairman of the Journal Management Committee, submitted the following recommendations:

(1) To charge for all reprints in excess of the 25 complimentary copies on the basis of the present rate for the first 50 copies and at the same rate for each 100 copies thereafter.
(2) To charge authors $5.00 per page in excess of 12 pages, instead of the present charge of $4.00.
(3) To consider publication of abstracts of literature on dairy production.

The Secretary-Treasurer then gave a report on membership. The Treasurer's report for the year 1935 was read and upon motion duly seconded was accepted. The report follows:

10 Knowles Avenue,
Kensington, Maryland
February 1, 1936

Mr. Roy R. Graves
Secretary-Treasurer
American Dairy Science Association
Washington, D. C.
Dear Mr. Graves:

In accordance with your request, I have made an audit of the records of the American Dairy Science Association, recorded necessary adjustments, closed the books as of December 31, 1935, and have drawn up the following statements and comments:

EXHIBIT "A"—BALANCE SHEET
As at December 31, 1935
EXHIBIT "B"—STATEMENT OF PROFIT AND LOSS
For the period December 31, 1934 to December 31, 1935
EXHIBIT "C"—BANK RECONCILIATION STATEMENT

COMMENTS

Cash in Bank, as shown by the books, was reconciled with bank statements furnished by McLachlen Banking Corporation of Washington, D. C., (See Exhibit "C"). Cash items held for collection represent two money orders held for collection by bank, not included in 1935 deposits.

Bonds appear on the balance sheet at par and were recorded according to your information.

Accounts Receivable—Returned checks were set up in December 1934 from information received from your bank statements. Information received from you makes it appear probable that all these checks were made good, although improperly credited again to membership fees and subscriptions. They were, therefore, deducted from 1935 income.

Accounts Receivable—Advertising totaling $77.69 was set up from information received from the Editor. The Editor's statement showed $83.60 due, however, $5.91 was received on December 31, 1935.

The following discrepancy between the Editor's advertising statement and the records of the American Dairy Science Association is shown below:

	Editor	Secretary-Treasurer
Accounts Receivable 1934	$ 79.55	$ 40.82
Accounts Receivable 1935	77.69	77.69
Advertising 1935	1,235.89	1,318.80

The discrepancy is probably accounted for by the Secretary-Treasurer's inclusion of some receipts in 1935 income which rightfully belonged in 1934 due to lack of proper information from Science Press.

I have estimated the inventory taken by Professor Dahlberg, as Editor, for 1935 Journals at $100.00. In accordance with last year's precedent, 80% of this amount has been set up as a reserve to decrease the inventory to the amount of probable future sales. This inventory included only 1935 Journals on hand at December 31, 1935. A cost of sales, therefore, could not be computed.

The Profit and Loss Statement shows the amount of purchases as expenses under the various headings. These costs were recorded on a cash basis from the Cash Book.

Deferred income represents payments made in 1935 on 1936 subscriptions and memberships.

Respectfully submitted,
CHARLES E. R. ADAMS, *Public Accountant*

AMERICAN DAIRY SCIENCE ASSOCIATION
WASHINGTON, D. C.

EXHIBIT "A"

BALANCE SHEET
As at December 31, 1935
Assets

Cash in Bank		$3,651.82	
Cash—items held for collection		10.35	$3,662.17
ACCOUNTS RECEIVABLE—			
Advertising—December 1935 Journal		77.69	
Returned checks		15.00	
Accrued Interest Receivable		60.00	152.69
Inventory—Journals (see comments)		625.00	
Less Reserve		500.00	125.00
Investments—Bonds			4,000.00
TOTAL ASSETS			$7,939.86
Liabilities and Capital			
ACCOUNTS PAYABLE			3.00
Deferred Income			982.12
CAPITAL:			
Capital—December 31, 1934 per Balance Sheet of that date		$5,779.29	
Add Estimated value of Journal Inventory for year 1935	$20.00		
Less loss on collection of Accounts Receivable	.40	$ 19.60	
Net profit for period		1,155.85	$6,954.74
TOTAL LIABILITIES AND CAPITAL			$7,939.86

AMERICAN DAIRY SCIENCE ASSOCIATION
WASHINGTON, D. C.

EXHIBIT "B"

STATEMENT OF PROFIT AND LOSS

For the period December 31, 1934 to December 31, 1935

INCOME:			
Membership Fees		$3,488.23	
Subscriptions		2,931.20	
Advertising		1,318.80	
Single and Back copies		52.12	
Reprints		83.56	
GROSS OPERATING INCOME			$7,873.91
OPERATING EXPENSES			
Journal		5,313.03	
Reprints		71.10	
Handling and Advertising Subsc.		261.10	
Postage and Stationery—S. P.		21.86	
Miscellaneous Expense—S. P.		126.36	
Editorial Expense:			
Salary	$500.00		
Telegrams & Postage	53.33	553.33	
Secretary-Treasurer			
Salary	200.00		
Postage & Expenses	20.00	220.00	
Divisional Allotment		75.00	
Accounting and Bookkeeping		25.00	
Association Stationery		29.00	
Federal Check Tax		.12	
Collection and Exchange		1.87	
Miscellaneous		43.91	
Annual Meeting		40.25	
TOTAL OPERATING EXPENSE			6,781.87
NET OPERATING PROFIT			1,092.04
NON-OPERATING INCOME:			
Bond Interest		105.00	
Less Bond Premium on Bond Purchased		41.19	63.81
NET PROFIT TRANSFERRED TO "EXHIBIT A"			1,155.85

BANK RECONCILIATION STATEMENT

EXHIBIT "C"

American Dairy Science Association, Washington, D. C.
As at December 31, 1935

Bank Balance, December 31, 1935		$ 4,577.74
Add outstanding Deposits		
Science Press	$ 237.49	
Science Press	200.86	438.35
		$ 5,016.09
Deduct Outstanding Checks		
The Maruzen Company	5.00	
Charles Shepardson	25.00	
Western Union	.63	
Science Press	815.41	
Charles Adams	25.00	
Cash—Secretary-Treasurer	5.00	
Science Press	483.38	
Crowell Publishing Company	4.85	1,364.27
Adjusted Bank Balance		$ 3,651.82
Book Balanced December 31, 1934	3,950.40	
Add Cash Receipts	8,455.25	12,405.65
Deduct Cash Disbursement		8,753.83
Book Balance December 31, 1935		$ 3,651.82

The recommendation of the Board of Directors was then read:

1. A notice of dues be sent to the membership the latter part of October, and that the January issue of the Journal not be sent to members until after they had paid their dues. Recommendation adopted.

2. That the names of all applicants for membership be published in the JOURNAL OF DAIRY SCIENCE. Recommendation adopted.

3. The following amendment was recommended: The Board of Directors shall consist of ten members, as follows: Six elected by the active membership, the retiring President, the President, the Vice-President, and Secretary-Treasurer, who shall be an ex-officio member.

At the first election under this constitution as amended, one director shall be elected for a term of one year, one for a two-year term, and two for a three-year term, thereafter two directors shall be elected each year, whose terms of office shall be three years. The terms of all directors begin October 1.

Upon motion by H. B. Ellenberger and seconded by E. C. Thompson the amendment was carried.

Upon motion duly seconded the action of the Board of Directors was adopted.

E. J. Perry, Chairman of the Extension Section, then gave the following report:

REPORT OF EXTENSION SECTION

The Extension Section continued the policy adopted in 1935 of having committee reports presented in the regular sectional meetings. Four committees, namely, the Testing, Breeding, Feeding, and Calf Club committees gave reports of surveys and studies made by the members on methods and subject matter presentation. These committee reports gave evidence of much work and preparation on the part of the committee members.

The Exhibit of Extension projects and methods was the most complete and the best organized of any of the previous two years.

Twenty states and the Bureau of Dairy Industry prepared exhibits. These exhibits were explained and discussed at a special session.

The regular business session was held Thursday, June 18, 1936, S. J. Brownell, of New York, being elected secretary. According to action taken in 1935, the 1936 secretary becomes vice-chairman for 1937 and the 1936 vice-chairman becomes the 1937 chairman. The chairman for 1937 will be C. L. Blackman, of Ohio, and the vice-chairman, Earl Schultz, of Iowa.

We are proud to report a membership of 62 extension men with over 50 regular attendance at this convention.

E. J. Perry, *Chairman*
Earl Schultz, *Secretary*
Extension Section
June 19, 1936

Upon motion duly seconded, the report was received and approved.

L. M. Thurston, Chairman of the Manufacturing Section, gave a report of the Manufacturing Section, which was, upon motion duly seconded, received and approved.

REPORT OF MANUFACTURING SECTION

The meetings of the manufacturing section this year have been well attended and interest has been maintained well throughout the sessions, thanks to the cooperation of the authors of papers in keeping within the time limit prescribed in nearly all cases.

At the judging demonstration on June 16 approximately 100 people were present and a profitable discussion of the ice cream score card with regard to standardization of the evaluation of defects developed.

Some very helpful and much needed work has been accomplished by this section during the past few years through the activity of committees. Committees at work during the year were as follows:

Chemical methods for the analysis of milk and dairy products. (Thirty members divided into subcommittees. E. S. Guthrie, Chairman.)

Bacteriological methods for the analysis of milk and dairy products. (Twenty-nine members divided into subcommittees. H. Macy, Chairman.)

Judging dairy products. (H. W. Gregory, Chairman.)

Methods of determining the curd tension of milk. (L. H. Burgwald, Chairman.)

Revision of score cards for the sanitary inspection of dairy farms and milk plants. (C. J. Babcock, Chairman.)

All these committees have been active throughout the year. Many methods for the chemical, bacteriological and physical examination of milk and dairy products are being

studied by certain of these committees. Some of these methods already found satisfactory, have been published in the JOURNAL, and many more undoubtedly will be made available as time goes on. Sentiment of members regarding a suggestion by Dr. Macy was such that it was decided to appoint a committee to study the feasibility of supplying a loose-leaf manual of the methods reported by these committees. It is proposed that the manual would be sold on a subscription basis and kept up to date periodically by furnishing separates to be incorporated in the manual.

The committee on the judging of dairy products has been cooperating closely with the Dairy and Ice Cream Machinery and Supplies Association in conducting the annual contest in judging dairy products and selecting students to receive the scholarship awards offered by the above mentioned Association. This committee reports that the Dairy and Ice Cream Machinery and Supplies Association is well pleased with the present system of awarding scholarships on the basis of teams rather than individuals.

The manufacturing section took action directing that committees be appointed by the retiring chairman rather than by the incoming chairman. This action was taken in order that the committees may be appointed more promptly than has been possible in the past.

Officers elected to take charge of the section October 1, next, are:

P. H. Tracy, Chairman
J. C. Marquardt, Secretary.

L. M. THURSTON, *Chairman*

Mr. K. S. Morrow, Chairman of the Production Section, gave a report of the Production Section, which was, upon motion duly seconded, received and approved.

REPORT OF THE PRODUCTION SECTION

The Production Section met in Room 8 of the Dairy Building at the times scheduled on the program. K. S. Morrow, of New Hampshire, was in the chair. All the papers but one that were listed on the program were given. At the afternoon session on Wednesday, June 17, the average attendance was 180, at the A. M. session on Thursday, June 18, the average attendance was 125, and at the P. M. session on the same day about 100 were in attendance.

At the business session of the Production Section, held at 1: 00 P. M. on June 18, reports of the Students Judging Committee, the Breeds Relations Committee, and the Pasture Investigations Committee were read, and after some discussion were adopted and filed with the Secretary. The report of the Student Judging Committee introduced one important change which allows admission to the Students' Judging Contest of Teams from schools in the United States other than Land Grant Colleges, provided such institutions offer a full degree course in agriculture with a full major in Dairy Production in a division of Animal Husbandry or Dairy Husbandry whose application is approved by the rules committee.

In the report of the Breeds Relations Committee an important change consisted in permitting equal part sampling for composite testing.

The new standing committees of the Production Section were appointed as follows:

Breeds Relations Committee:
S. M. Salisbury (Ohio), Chairman—1 year
R. T. Harris (Wisconsin)—1 year
C. M. Shepardson (Texas)—2 years
E. M. Shultz (Iowa)—2 years
C. E. Wiley (Tennessee)—3 years
J. G. Hays (Michigan)—3 years

Students Judging Contest Committee:
I. W. Rupel (Wisconsin), Chairman
P. Reaves (Virginia)
E. Hanson (Iowa)
J. F. Kendrick (Washington, D. C.)
J. R. Dice (North Dakota)

It was moved, seconded, and adopted that the special committee on methods of measuring results of Pasture Investigations be continued, this committee to be made up as follows:

R. H. Lush (Louisiana) Chairman
I. R. Jones (Oregon)
C. B. Bender (New Jersey)
G. Bohstedt (Wisconsin)
R. B. Becker (Florida)

It was moved, seconded, and adopted that a committee of three be appointed by the chair, to investigate on standard methods of the Manufacturing Section and include methods of experimentation and analysis of interest to the Production Section. The following committee was appointed to conduct this study:

A. E. Perkins (Ohio), Chairman
W. E. Peterson (Minnesota)
C. F. Huffman (Michigan)

It was moved, seconded, and passed that the matter of including abstracts of Dairy Production papers in the JOURNAL be referred to the JOURNAL Management Committee.

Consideration was invited to having a vice-chairman of the Production Section who would automatically become chairman during the following year, and as a result a motion making such a system effective was adopted.

The Nominating Committee, of which Dr. Gullickson, of Minnesota, was chairman, presented the following names for offices in the Production Section :

For Chairman { R. B. Becker (Florida) / F. W. Atkeson (Kansas)
For Vice-chairman { S. I. Bechdel (Pennsylvania) / W. E. Krauss (Ohio)
For Secretary { I. W. Rupel (Wisconsin) / D. Fourt (Idaho)

Upon vote of the 45 members of the Production Section present, F. W. Atkeson was elected Chairman, W. E. Krauss, Vice-chairman, and I. W. Rupel, Secretary.

The business meeting of the Production Section adjourned at 2: 30 P. M. This report is respectfully submitted by

K. S. MORROW, *Chairman*
W. E. KRAUSS, *Secretary*

President Ruehe then appointed a committee consisting of L. M. Thurston, F. C. Button, and A. C. Dahlberg to act for the Association on an exhibit to be held by the American Association for the Advancement of Science at Atlantic City in the Court of Dairy Industries to show the results of research and scholarship.

Chief O. E. Reed, Chairman of the Committee on National Research Councils, gave the following report, and upon motion duly seconded, it was adopted.

Upon motion by J. H. Frandsen, seconded by O. F. Hunziker, it was voted that Chief O. E. Reed represent the American Dairy Science Association upon this committee for the ensuing year.

The nomination committee then gave their report as follows:

Our Constitution with the new amendment, increasing the Board of Directors to six active members, requires the nomination of the following slate for the ensuing year:

Vice President
2 Directors for 3 year terms
1 Director for 2 year term
1 Director for 1 year term

Your committee on nominations have met and beg to recommend the following names for nominations:

Vice President:
H. W. Gregory, Indiana
J. W. Linn, Kansas

Directors:
For 3 year term:
F. C. Button, New Jersey
H. O. Henderson, West Virginia
E. G. Hood, Canada
Earl Weaver, Oklahoma

For 2 year term:
J. A. Nelson, Montana
C. N. Shepardson, Texas

For 1 year term:
H. P. Davis, Nebraska
M. J. Regan, Missouri

Respectfully submitted
The Nominating Committee
C. R. GEARHART
A. H. KUHLMAN
HAROLD MACY
E. J. PERRY
O. F. HUNZIKER, *Chairman*

The resolutions committee then submitted the following report:

Whereas the American Dairy Science Association assembled in Annual Convention at the Pennsylvania State College at State College, Pennsylvania, has enjoyed a most satisfactory program and the many courtesies extended them, therefore be it resolved:

(1) That the membership and wives tender their deep appreciation to the staff of the Pennsylvania State College and the organizations which have contributed to the success of the 31st annual meeting.

(2) That the program committee be commended for the arrangement of papers according to subject matter and further extension of the symposium idea be recommended.

(3) That those who present papers before the general Association or sectional meetings make definite preparations to the end that their papers be given within the time limit allotted so as not to jeopardize interest in or curtail presentation of succeeding papers on the same program.

That in most instances those papers presented without reading are more interesting, more effective, and stimulate more discussion than those read.

(4) That an appreciation be extended for the work of the several committees on standard methods of analytical procedure for dairy products and that this work be further extended into other fields of dairying.

(5) That the Association feels its loss in the death of one of its members, Professor Richard W. Smith, formerly of the University of Vermont, and that it expresses its deepest sympathy to the bereaved family.

(6) Whereas the members of the American Dairy Science Association are vitally interested in education, be it resolved that the program committee each year be instructed to arrange to have at least one speaker on the general program to discuss such subjects as the aims and objectives in education and the means of attaining these ends.

Resolutions Committee
J. A. NELSON
L. M. THURSTON
C. L. BLACKMAN
R. H. LUSH
W. E. PETERSEN, *Chairman*

Upon motion duly seconded the report was accepted.

President Ruehe then reported that the Board of Directors had accepted the invitation from the University of Nebraska to meet in Lincoln at a suitable date in June 1937.

J. B. Fitch moved and J. H. Frandsen seconded that a committee be appointed to report back to the Association regarding the attitude of the American Dairy Science Association on the standardization of milk for butterfat. The President appointed the following committee: P. F. Sharp, J. H. Frandsen, C. L. Roadhouse, A. D. Burke, and W. D. Dotterrer.

Upon motion duly seconded the meeting was then adjourned.

MEETING OF BOARD OF DIRECTORS

June 18, 1936, 12:00 noon.

Present: H. A. Ruehe, L. A. Rogers, C. R. Gearhart, and R. B. Stoltz. Absent: R. R. Graves and Martin Mortensen.

Mr. Gearhart moved and Dr. Rogers seconded that the Secretary be authorized to notify the membership of their dues for the ensuing year in the month of November and that the Journal be not sent to delinquent members.

Dr. Rogers moved and Mr. Gearhart seconded that the names of all applicants for membership in the American Dairy Science Association be published in the Journal.

H. P. Davis came before the Directors and invited the Association to hold its next meeting at the University of Nebraska at Lincoln. Upon motion by Dr. Rogers and seconded by Mr. Gearhart, the invitation was accepted.

O. F. Hunziker, Chairman of the Journal Management Board, then submitted the following report: Your committee on Journal Management begs to make the following recommendation—

1. To charge for all reprints in excess of the 25 complementary copies on the basis of the present rate for the first 50 copies and at the same rate for each 100 copies thereafter.
2. To charge authors $5.00 per page for each page in excess of 12 pages.
3. To consider publication of abstracts of literature on dairy publication.

Upon motion by Mr. C. R. Gearhart and seconded by Mr. R. B. Stoltz, the recommendations were adopted.

A report was then read from the committee on Solids-not-Fat-Standards.

Upon motion by L. A. Rogers and seconded by C. R. Gearhart the report was laid on the table. Upon motion duly seconded the meeting was then adjourned.

June 18, 1936—4 P.M.

Old Main Building

Present—H. A. Ruehe, R. R. Graves, C. R. Gearhart, R. B. Stoltz, A. C. Dahlberg, L. A. Rogers.

Absent—Martin Mortensen.

The following amendment was proposed:

That section 5 of the By-Laws of the American Dairy Science Association referring to Associate membership be changed to read as follows:

"Associate Membership of this Association shall consist of upper division and graduate students who are majoring in dairying or dairy industry in a regularly organized college or university. Applications for Associate Membership must carry the approval of the head of the department of dairying in the institution where the student is enrolled. Members of local chapters of the American Dairy Science Association in institutions where such student organizations exist are eligible for recommendation for membership as Associate Members of the American Dairy Science Association when their applications are approved by the head of the department of dairying in the institution where the chapter is located. Associate Membership expires one year after the holder ceases to be enrolled as a student, but an associate member may then become an active member upon payment of active membership dues."

After discussing at some length the amendment regarding the associate membership the thought was expressed that this matter be laid over until

our next meeting, at which time it should be brought up for further consideration. This will permit the members a year's time to consider as to whether or not the associate membership should be continued. Upon motion by R. R. Graves and seconded by C. R. Gearhart the amendment was laid on the table.

The question then arose as to whether or not the Association could be of greater financial aid to the various division meetings. The Board then instructed the Secretary to advise the officers of the divisions that we are sympathetic with their financial conditions and problems, but that we are not able at the present time to increase the allotment made to them. The Board suggests that the various divisions adopt the same policy as our organization in making a registration charge in order to defray the expenses at the division meetings. Upon motion duly seconded the Board was then adjourned.

EDITOR'S REPORT FOR 1935 TO COMMITTEE ON JOURNAL MANAGEMENT

On account of the labor involved in the organization of the publication of abstracts of literature on Milk and Milk Products, the editor has been at some handicap in finding time to actually digest the activities of the JOURNAL OF DAIRY SCIENCE for 1935. This report is, therefore, not as complete as desired.

MAILING LIST

There was a substantial increase in the total paid mailing list of the Journal for 1935. Science Press mailing cards for 1934 showed a paid list of 1157 while the list for 1935 was 1344 of which 727 were members and 617 were subscribers. The trend toward a larger proportion of members to subscribers is undoubtedly desirable and due primarily to the activity of the Association.

ADVERTISING

The total pages of advertising in 1935 were 56¾ with 58¼ in 1934. The maintenance of advertising in 1935 was not particularly good as there should have been a decided increase but the total advertising is actually as good as it has ever been in the JOURNAL OF DAIRY SCIENCE.

The advertising rates have not changed and are somewhat low as has been mentioned on several occasions. The cost of securing and publishing advertisements is not high but it increased this year due to increased circulation.

After discussion with the Secretary-Treasurer it was decided to have advertising solicited thru his office rather than by the editor. After many years of effort a change of policy and of the individual soliciting advertising is undoubtedly good and it is to be hoped that high class advertising may be increased in 1936. The abstract service should be an aid and some advertisers have mentioned the increased value of the Journal to them.

Two companies have requested preferred space in the text and 12 full pages of advertising were lost by the decision to keep ads out of the text. It is believed that the Journal must continue the policy of restricted space for advertising at the beginning and end of the Journal.

Material Published

The Journal published 79 manuscripts, 10 Association announcements, the annual program, the membership lists, and devoted the July number to the abstracts of papers given at the annual meeting. It furnished 450 reprints of the July number to members attending the annual meeting. This is the year of greatest printing service to the Association.

The Journal is still up-to-date in the publication of manuscripts as was reported last year for 1934. Manuscripts have regularly appeared in the Journal within six months or less after date of receipt.

Reprints

Consideration has been given by the editor to the charge for reprints. Comparative data are given in table 1 to show costs to authors or educational agencies printing in several Journals.

Our Association now sells reprints below the cost of state printing. This may be a desirable policy but it should be discussed. It would seem to be good business to furnish our members with 50 reprints at the present cost price and to make a reasonable profit on additional reprints. This could easily be accomplished by charging the same total amount for each 100 reprints as it now charged for the first 50. As shown in table 1 this would give a charge of 5¼ cents each for a 16 page article, an increase of $2.80 per 100 reprints above the present rate.

Page Style

Several individuals have called the editor's attention to the trend toward two column pages and have recommended this style for the Journal. After corresponding with Science Press the editor is inclined to believe that the present printed page should not be altered. A narrow column of three inches is quite suitable for scientific printing but the two to two and one-half inch column as used for popular writings is too narrow for scientific writings.

Abstracts of Literature on Milk and Milk Products

The agreement for the publication of abstracts of literature on milk and milk products was made with the International Association of Milk Dealers and of Ice Cream Manufacturers just in time to rush some abstracts into the January, 1936 Journal. Although this activity actually began in 1936 the organization began in 1935.

This service includes all of the State and Federal Experiment Stations, several European Experiment Stations, and 49 Journals. There is a group of 5 editors, 86 abstractors, and an editorial committee of 6 who are all active in this service. It requires 90 letters to send one communication to each abstractor and editor. The extensiveness of the arrangement is shown by the attached directory taken from the Journal.

The work of organization is over and the printing of back abstracts has been completed. The Journal now serves as the continuation of the abstracts previously published independently by the other two Associations.

The publishing agreement called for an increase of 400 above our mailing list of 1935 or a total paid list of 1744. The mailing list was 1549 on May 14 or 195 short of the final goal for the year. It is too early to anticipate the final mailing list but continued efforts will be needed to reach it. The returns thus far are very gratifying. It is almost needless to state that the Secretaries of the three Associations have taken the leading part in promoting the mailing list.

Plans for the Immediate Future

The Journal is serving our Association and the industry well and its usefulness has been extended yearly. There always seems to be some important change which should be made.

It is evident that the abstract service should be extended when possible to include dairy cattle. This problem should be discussed at the annual meeting to ascertain the need for the service and a method to increase circulation to permit the development of this service, if desired.

Another activity which is badly needed is a standardization of usage in common dairy terms. The Dairy Science Association is the proper body to set the standards for good dairy science language. After considerable correspondence and thought it is evident that there is a real need for this service and that it can best be done by the editor and editorial staff acting with power granted by the Association.

Recommendations

1. Obtain the opinion of the Association as to the desirability of increased charges for reprints purchased over 50 and the elimination of free reprints.
2. Consider the feasibility of extending the abstract service to include dairy cattle.
3. Secure approval of the Association for the editorial staff to establish standard dairy terms for uniformity of style in the Journal.

Charges for Journal Reprints

First 50 Copies

	Complimentary	4 pp.	8 pp.	16 pp.
Science	0	3.70	5.40	7.60
Dairy Science	25	1.55	2.75	5.25
Horticultural Science	0	3.05	5.00	—
Agronomy	0	2.65	4.25	7.45
Extra 100 Copies				
Science		0.75	1.20	1.80
Dairy Science		0.80	1.50	2.80
Horticultural Science		2.70	5.50	—
Agronomy		1.60	2.70	4.90

The 5-year average cost of printing Technical Bulletins by the New York Agricultural Experiment Station ordered in average lots of 3,900 copies was 5 cents per copy. Minimum order required to secure these prices was 1000 copies. Cost in Journal of Dairy Science without covers for 28 page reprints is 4.9 cents after ordering 50 copies at 9.1 cents each. Minimum order required to secure low price is 150 copies.

REPORT OF JOURNAL MANAGEMENT COMMITTEE

State College, Pa.

June 19, 1936

Another milestone in the history and development of this Association and of the Journal of Dairy Science has been turned; I refer to the publication of the Abstracts of the literature of milk and milk products. This enterprise has been successfully

launched and is now well under way. It began on schedule time with the publication of the January issue.

The tentative agreement made at last year's meeting with the International Association of Milk Dealers and the International Association of Ice Cream Manufacturers was signed late in November by all parties concerned, with but slight changes in wording and substantially unchanged in principle. The figures available so far suggest that while the increased size of the JOURNAL with the Abstracts has increased the cost of the JOURNAL very appreciably, we should at least break even or better by the end of this year.

Due to the delay in ratification of the agreement, our regular announcement for subscriptions and our solicitations for advertising contracts had to be sent out without any mention of the Abstracts. But in spite of this handicap our returns have been very gratifying and they will naturally increase due to the business-getting lever of the Abstract Service. Indeed, the Abstract Service may well be looked upon as our most promising financial asset.

It appears pertinent to mention in this connection that the JOURNAL has made a considerable operating profit in the past, averaging over $1,000 annually. If, therefore, this first year of the promotion of the Abstract Service should show a slight loss, such deficit would be amply covered by the accumulated reserve. Let us not be unmindful that the fundamental and permanent strength of our organization lies in our permanent membership. And you members may know of dairy teachers whom we need and who in turn need our Association and all it stands for. Further, when members, and particularly you men at the dairy schools and experimental stations are answering technical inquiries, there appears no good reason why such inquirers should not be referred to the JOURNAL OF DAIRY SCIENCE, thus selling them on the idea of subscribing for the JOURNAL.

The progress that has been made and the success that has been achieved have been due to a large measure to the generous cooperation on the part of so many of you members in your membership drives and abstracting service.

At the beginning of this latter enterprise we had to limit the field of literature covered due to financial returns. Since the milk and ice cream associations sponsored for the abstracting of the literature of milk and ice cream it was decided to confine the abstract service to milk and milk products for the first year and then branch out into dairy production as soon as we could see our way clear to extend the abstract service. The publication of abstracts on the literature of dairy production and the commercial dairy cattle business are under serious consideration right now and we are anxious to extend this service just as soon as it becomes financially feasible.

The committee on JOURNAL Management wishes to repeat its sincere appreciation of the unfailing cooperation of members and to assure you that the administrative affairs of your JOURNAL are in good hands. The busy men on the firing line, your able JOURNAL Editor, A. C. Dahlberg, and your experienced permanent Secretary, R. B. Stoltz, who are taking care of the great mass of daily details of administration are rendering this Association a priceless service of untiring labor and wise judgment. Their efforts merit our whole-hearted support and our active cooperation.

O. F. HUNZIKER, *Chairman*

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

Published in cooperation with

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R. C. HIBBEN, 1105 Barr Bldg., Washington, D. C., Exec. Sec.

INTERNATIONAL ASSOCIATION OF MILK DEALERS
R. E. LITTLE, 309 W. Jackson Blvd., Chicago, Illinois, Exec. Sec.

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American Journal of Public Health
Archives of Pediatrics

Biochemical Journal
Biochemische Zeitschrift

Canadian Dairy and Ice Cream Journal
Certified Milk

Dairy Produce Review
Dairy World
Deutsche Molkerei Zeitung

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Ice and Refrigeration
Ice Cream Field
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Journal of American Medical Association
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Journal of Biological Chemistry
Journal of Dairy Research
Journal of Dairy Science
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Journal of Infectious Diseases
Journal of London Chemical Society
Journal of Nutrition
Journal of Pathology and Bacteriology
Journal of Physical Chemistry

Kaseindustrie
Kolloid-Zeitschrift

Lancet
Le Lait

Milchwirtschaftliche Forschungen
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Molkerei Zeitung

National Butter and Cheese Journal

Pacific Dairy Review

Zeitschrift für Infektionskrankheiten Parasitäre Krankheiten und Hygiene der Haustiere
Zeitschrift für Physikalische Chemie, Abt. A and B
Zentralblatt für Bacteriologie

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers
International Association of Milk Inspectors

National Dairy Experiment Station, Hillerod, Denmark
National Institute for Research in Dairying, Reading, England

New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

A Simplified, Improved Method for the Preparation of Cream for Churning. ASSEN KANTARDJIEFF, Univ. of Sofia, Bulgaria. Milchw. Forsch. *17*, 5, p. 206, Dec., 1935.

Rich cream is pasteurized and cooled to 5–8° C. A quantity of skimmilk equal to 50–65 per cent of the weight of the cream is heated to 90° C., cooled to 43° C., inoculated with *Lactobacillus bulgaricus*, alone or with *Streptococcus thermophilus*, held at 43° C. until the acidity reaches 1.58–1.80 per cent. The starter is then cooled to such a degree that, when it is mixed with the cream, the mixture is about 1° C. below the churning temperature and the acidity about .675–.765 per cent. The cream is then churned and the butter worked as usual. The process seems to be especially useful for sheep or buffalo cream. The buttermilk has the healthful properties of Yogurt. Complete directions and data are given. H.M.

Aroma Production of Fermented Milk. O. K. PALLADINA, W. A. MAZJUKEWITSCH, E. L. MILOWA AND N. S. GRIGORJEWA. Central Fat Inst., Leningrad, U. S. S. R, Milchw. Forsch. *17*, 5, p. 222, Dec., 1935.

The flora and general characteristics of several fermented milk beverages and starters are described. Observations were made on the biochemical changes produced in milk by individual strains or combinations of *Streptococcus lactus, S. cremoris, Leuconostoc Mesenteroides, S. citrovorus, S. paracitrovorus, Lactobacillus acidophilus, L. bulgaricus, L. casei,* Streptocasterium and Betabacterium. Data are presented on the relation between pH and total acidity, the effects of temperature of incubation, various combinations of strains, symbiosis, addition of citric acid and synthetic diacetyl and the action of diacetyl produced by cultures. Starters of selected strains of *S. cremoris* were found desirable for margarine, with an active strain of *S. lactis* for a more marked flavor. To improve flavor and to avoid high acidity, aroma-producing cultures were introduced especially for storage goods. The formation of diacetyl did not always mean a good flavor in the starter but a good active culture of aroma cocci produced a high volatile acidity as well as diacetyl, while the best starters always developed diacetyl. Lactobacilli producing diacetyl and high acidity were not satisfactory although betacocci were good. Synthetic diacetyl was held in fermented milk only in the presence of the aroma strains plus *S. cremoris* while *S. lactis* brought about its decomposition. H.M.

CHEESE

Determination of Metals in Milk Products. I. Determination of Copper in Cottage Cheese. G. SCHWARZ, O. FISCHER AND H. STOTZ. Chem. Inst., Prussian Exp. and Research Inst., Kiel, Germany. Milchw. Forsch. *17*, 6, p. 314, April, 1936.

A method for determining copper in cottage cheese (quarg) is outlined in detail and extensive data are reported. The quarg is first treated with concentrated H_2SO_4 and HNO_3 in Kjeldahl flasks to destroy the organic matter. The copper is detected by means of "dithizon" (diphenylthiocarbazone) which produces an intensely colored compound in the presence of copper. The depth of color is measured by a photometer. Considerable amounts of trivalent iron in the quarg reduce the accuracy of this method but this disturbing influence may be eliminated by a treatment of the fluid with hydrazine sulphate which converts the iron into the ferrous state. Further contributions are promised to give methods for determining Cu and Zn in other dairy products. H.M.

Behavior of Different Groups of Lactic Acid Bacteria in Emmental Cheese. I. Quantitative Investigations. KARL J. DEMETER AND SCHMID. Bact. South German Research Inst. for Dairying in Weihenstephan, Tech. College, Munich, Germany. Milchw. Forsch. *17*, 5, p. 244, Dec., 1935.

The milk used for the manufacture of Emmental cheese in Allgäu, showed rather uniformly high counts of lactic acid bacteria. In the early stages of curdling, the number of streptococci increased more than the lactobacilli. In the course of scalding and immediately thereafter, a significant decrease in streptococci occurred, while the long rods remained constant. The selective action of heat, subsequently and during the pressing, resulted in an increase of the thermophilic streptococci and lactobacilli whereby the latter became much more prominent. In further course of ripening, the rods decreased quite uniformly until the end of the ripening while the streptococci after three weeks in the fermentation cellar reached a lower stage than previously, but finally increased considerably again up to the end of ripening in the storage cellar. The originally-dominant *S. lactus* types completely receded from the time of exposure to the salt bath. At the same time, *S. thermophilus* reached its high point in order to clear the field in turn for the betacocci and other thermophilic streptococci in the course of further ripening. A special relation between the appearance of betacocci and green feed could also be found (May cheese). Within the Lactobacillus group, the streptobacteria appeared from the third week in the fermentation cellar and their numbers further increased until the seventh week only to decrease again after that time.

So the streptobacteria appeared to play an important role in the ripening at that time. In cheese that was defective, there was a deviation from the normal course of streptococci and streptobacteria. The bacterial flora of rennet also merits consideration. H.M.

Behavior of Individual Groups of Lactic Acid Bacteria in Emmental Cheese. II. Systematization of Lactic Acid Bacteria Found. KARL J. DEMETER AND HERMAN SCHMIDT. Bact. Inst. South German Research Inst. for Dairying, Weihenstephan, Tech. College, Munich, Germany. Milchw. Forsch. *17*, 5, p. 270, Dec., 1935.

The bacteria isolated from 10 Emmental cheese at various stages in the manufacturing and curing processes are described according to the system suggested by Orla-Jensen. The importance of *S. thermophilus*, first pointed out in the United States, was confirmed. Another Streptococcus, not identical with *S. thermophilus* was probably closely related to *S. faecium* Orla-Jensen was found. It was present throughout the manufacturing process and perhaps is related to the ripening streptococci mentioned by Hanusch. A betacoccus was found in good and bad cheese in approximately the same numbers as well as *Tetracoccus liquefaciens* and *Tetracoccus casei* which were found only in limited numbers. *Thermobacterium helveticum*, which disappears toward the end of ripening, *Thermobacterium lactis*, which takes the place of the former, *Streptobacterium casei*, which predominates in normal cheese after 3 to 6 weeks ripening in the cellar, and *Streptobacterium plantarum*, which, until now, has not been observed in Emmental but found in astonishing numbers only in very unsuccessful cheese at the time of green or beet feeding, are also described. Acidoproteolytes (Forini) were found so rarely that their importance in the normal ripening of Emmental is again questioned. Further investigations are necessary to determine the role of each type in the ripening process. H.M.

Contributions to the Chemistry of Cheese Ripening. III. Knowledge of Caseoglutin. W. GRIMMER AND WALTER LENGE, Univ. of Konigsberg, Germany. Milchw. Forsch. *17*, 6, p. 352, April, 1936.

Caseoglutin obtained from ripened Tilsiter Cheese was shown to be made up of three fractions characterized as follows: (a) caseoglutin alpha, insoluble in 40 per cent acetone, (b) caseoglutin beta, soluble in acetone, isoelectric point, pH 5.3, amounts to 15.5 per cent of original caseoglutin and (c) caseoglutin gamma, soluble in acetone, isoelectric point, pH 7.0, amounts to 12.8 per cent of original caseoglutin. The fractions show a lower sulphur content than the raw product. The phosphorus content does not appear to be bound organically but rather mixed with $CaHPO_4$. The amino acids present in the alpha fraction were determined. The high leucine (15.13 per cent) and proline (7.1 per cent) content are striking

while valine, glutamic acid and the hexase bases are markedly lower than casein or the caseoglutin described by Grimmer and Schultzer. Extensive data are reported. H.M.

ICE CREAM

Distribution of Butterfat in Frozen Cream. H. C. TRELOGAN AND W. B. COMBS, Univ. of Minn., St. Paul. Milk Dealer *25*, 9, p. 44, June, 1936.

Results of this work indicate that cream does not freeze homogeneously under any of the conditions outlined. There is a reduction in the fat content around the sides and bottom of the frozen cream. Nevertheless, the fat distribution in cream frozen in cold storage is more uniform than in frozen milk, and the uniformity is relatively greater as the butterfat content of the cream increases. The migration of the butterfat in frozen cream can be explained in part by fat-rising for the lower-rising creams, but a more adequate explanation may be found in the manner in which the cream crystallizes.

Freezing of cream in cold storage is initiated when the aqueous part along the sides and bottom begins to solidify. As the ice crystals expand, they tend to push the fat globules toward the center. This accounts for the slightly reduced fat content along the sides and bottom. But the movement is checked as freezing progresses, because the ice bands growing in varied directions meet and form cavities in which fractions of the fat are trapped and are subsequently packed together with further growth of the ice crystals. The top of the cream is the last boundary to begin freezing, because of the air insulation in the can. When the top becomes totally frozen and rigid, pressure is gradually accumulated inside the cream with further freezing until a point is reached when the pressure causes the top to bulge. This inside pressure probably tends to inhibit further movement of the fat in the viscous fluid that is freezing and thus eliminates any concentration of the fat in the center of the freezing mass. As the freezing progresses, successively smaller portions of the fat are enveloped by the growing ice sheets until the center is solidified and the cream is totally frozen. C.J.B.

A New Time Saving Chart. THOMAS D. CUTLER, Ice Cream Trade J. *32*, 9, p. 22, Sept., 1936.

A computing chart is presented and directions given for its use in standardization. Dairy plant problems, such as the standardization of milk and cream, and the proportioning of ice cream mix ingredients, may be quickly solved by means of the chart. W.H.M.

Careful Sanitation is Necessary in Manufacturing Ice Cream. J. H. FRANDSEN, Mass. State College, Ice Cream J. *32*, 9, p. 26, Sept., 1936.

Bacteria counts, at frequent intervals, are recommended by the author. He also suggests methods for use in the washing and sterilizing of plant equipment. W.H.M.

Significance of Laboratory Tests in the Control of Ice Cream. F. J. BABEL, Ice Cream Trade J. *32*, 9, p. 35, Sept., 1936.

As stated by the author, "The purpose of this study was to compare: (1) tryptone-glucose-skimmilk agar, standard nutrient agar plus one per cent sucrose, and standard nutrient agar for determining the total bacterial count of ice cream; (2) brilliant green lactose peptone bile, formate-ricinoleate broth, Leifson's disoxycholate agar and Bacto violet red bile agar in detecting the presence of the Escherichia-Aerobacter group in ice cream; and (3) to determine the number of yeasts and molds, thermoduric, thermophilic, and spore-forming organisms in ice cream and their relation to the total count.

A summary of the results follows:

1. The analysis of 192 samples of commercial ice cream for total bacteria showed tryptone-glucose-skimmilk agar to be superior to standard nutrient agar on standard nutrient agar plus one per cent sucrose. Tryptone-glucose-skimmilk agar gave higher total counts and colonies of greater size than did the other two media. Standard nutrient agar plus one per cent sucrose gave, on the average, slightly higher counts and colonies of greater size than did standard nutrient agar.

2. Violet red bile agar was superior to sodium desoxycholate agar in the detection and enumeration of members of the Escherichia-Aerobacter group of organisms in ice cream.

3. No significant difference was found in a comparison of formate-ricinoleate broth and brilliant green lactose peptone bile in their ability to detect the presence of the Escherichia-Aerobacter group of organisms in ice cream.

4. Violet red bile agar and sodium desoxycholate agar are superior to formate-ricinoleate broth or brilliant green lactose peptone bile in detecting the presence of the Escherichia-Aerobacter group of organisms in ice cream.

5. The most frequent ratio occurring between thermophilic, thermoduric, and spore-forming bacteria in relation to the total count was 1 to 1 : 10.

6. Strawberry ice cream contained the largest number of spore-forming organisms as compared with vanilla or chocolate. Chocolate ice cream had the highest ratio of spores to total bacteria, indicating few spore-forming organisms.

7. A direct relation was secured between the total bacterial count and the yeast and mold count of ice cream. The yeast and mold count usually increased with an increase in the number of total bacteria. W.H.M.

Freezing Ice Cream. P. H. TRACY, Univ. of Ill., Urbana, Ill. Ice Cream Trade J. *32*, 7, p. 19, July, 1936.

The author reviews the literature on this subject mainly comparing the batch and continuous freezing. The factors which influence mix whipping are: percentage of butter fat, percentage of serum solids, sugar content, presence of stabilizers, salt content, amount of egg yolk used, acidity of mix, and homogenization and aging of mix.

Directions for care of brine and direct expansion freezers are given.

W.H.M.

Homogenization of the Mix. W. H. E. REID, Univ. of Mo, Columbia, Mo. Ice Cream Trade J. *32*, 6, p. 15, June, 1936.

Homogenization is discussed from standpoint of: quality of final product, influence of temperature, application of various pressures, effect on bacteria count and care of the homogenizer. W.H.M.

Selecting the Proper Ingredients to Make a Good Ice Cream. M. J. MACK, Mass. State College, Amherst, Mass. Ice Cream Trade J. *32*, 3, p. 23, March, 1936.

This article deals with the selection of ingredients for a good ice cream mix from the standpoint of economy, balance of solids, and quality of the final product. W.H.M.

The Use of Stabilizing Agents in Manufacturing Ice Cream. P. H. TRACY, Univ. of Ill., Urbana, Ill. Ice Cream Trade J. *32*, 3, p. 31, March, 1936.

The need for some form of stabilizing agent in the manufacture of commercial ice cream is commonly recognized. Gelatin is the most ordinarily used product, as a very satisfactory stabilizing agent for ice cream.

The popularity of gelatin in ice cream has encouraged the introduction of certain substitutes of which, sodium algenate, hygell, and pectin, are discussed as to the advantages and disadvantages as compared to gelatin as stabilizers for ice cream. W.H.M.

MILK

The Need for Better Methods of Feed Conservation in the Production of Premium Milk. JOHN HUNGERFORD, Blue Ribbon Farms, Kansas City, Mo. Proc. of 28th Annual Con. Intern. Assoc. Milk Dealers, Production Section. p. 42, 1935.

The author states his belief that stimulation to high production by heavy grain feeding may render dairy cattle more susceptible to mastitis. He reports that over 30 per cent of a herd under his supervision became infected

in the early spring of 1932 when being fed upon a ration of approximately 10 pounds alfalfa hay, 45 pounds silage and grain at the rate of 1 to 3. That fall they started to use feeds conserved by the A. I. V. process and decreased the grain ration to a ratio of 1 to 4 or 4½. Since starting this program the herd has been relatively free from mastitis. The author observes that whereas during the early spring months of the two previous years they had experienced heavy calf losses from pneumonia that since going on this A. I. V. feeding program the calf losses have been negligible.

During the period of three years of using the A. I. V. method of feed preservation there has been a decided improvement in the color of the winter milk and physical analysis for carotin and bio-assays for vitamin A have shown practically double the carotin content and 50 per cent more vitamin A potency than milk from another herd fed similar feeds conserved by the usual process. There was also strong indications that there was present in the A. I. V. produced milk a nutritional property which protected the experimental animals from pneumonia to a much greater extent than ordinary winter milk. The author states that from an economic standpoint the A. I. V. process is entirely practical. E.F.G.

Factory-built Milk Houses. Milk Dealer *25*, 10, p. 34, July, 1936.

A description is given of a low-cost factory-built milk house. The concrete work is the only part of the structure that is made on the farm.

C.J.B.

From Cow to Consumer. W. A. WENTWORTH, Milk Dealer *25*, 10, p. 2830; 44–46, July, 1936.

The author answers charges made against milk dealers the country over. He explains why the producer is paid according to the use to which the milk is placed; how producers in the milk industry have been faring compared with beef farmers, cotton farmers, grain farmers, and the like; how our system of many private distributors compares in efficiency with a single municipally-owned distribution system in Wellington, New Zealand.

C.J.B

Government Control and the Dairy Industry. H. P. DAVIS, Univ. of Nebr. Milk Dealer, *25*, 9, p. 90, June, 1936.

The author discusses the trend of public sentiment toward thinking of the milk supply in the same way that a water supply or sewage is regarded. He concludes that it is only through greater responsibility within the industry that we can have less governmental control. C.J.B.

Speaking from Experience about Bottled, Homogenized Milk. Milk Dealer, *25*, 9, p. 40, June, 1936.

The experiences of some milk dealers with homogenized milk are related. Practically all of these dealers report favorably for homogenized milk and some predict there is a big field for this product. C.J.B.

Milk Cooling and the Effect of Cooling on Flavor. LOUIS L. MONTEI, Moores and Ross, Inc., Columbus, Ohio. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Production Section, p. 32, 1935.

The use of various types of cooling equipment is described. The insulated storage tank is especially emphasized. Sources of off flavors in milk are enumerated and directions given for avoiding these flavors. The author stresses the importance of good flavor if milk consumption is to be maintained and increased. E.F.G.

The Value of Milk Judging Contests to the Milk Dealer. W. H. E. REID, Univ. of Mo., Columbia, Mo. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Production Section, p. 23, 1935.

The value of milk contests for producers, public health officials, plant employees, consumers and students is discussed separately for each of these groups. At a milk and cream judging contest recently sponsored by the University of Missouri, 56 teams chosen from 4,300 vocational agriculture students participated. E.F.G.

Advantages and Disadvantages from Dealer and Producer Standpoints in Receiving Milk Twice a Day. J. V. QUIGLEY, County Club Dairy Co., Kansas City, Mo. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, p. 8, 1935.

The author states that if all milk producing farms could be equipped with mechanical refrigeration there would be no reason to consider twice a day receiving of milk but that under the usual conditions there is no way by which milk can reach the plant in as good condition as by delivering it without cooling within two hours after milking. Twice a day delivery is a method of milk improvement which will cost the dealer more money for delivery but the author states that it is probable that those dealers who have had it forced upon them by health agencies or who have had experience with it through their voluntary adoption of it as good business practice would not, if it were possible, go back to once a day receipt of milk, particularly if their market lies in a warm area. E.F.G.

New Developments of Milk Plant Equipment During Past Year. E. N. MUZZY, Carnation Company, Seattle, Washington. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 3, 1935.

Thirty or more of the leading manufacturers of equipment submitted data and information which were summarized to indicate recent trends.

Simplicity with fewer parts to wear out, easier and quicker cleaning and durability were stressed. More liberal use of stainless steels and special metals and advances in welding technique, especially butt welding, were noted. E.F.G.

Power Plant Operation. RALPH COPP, Pevely Dairy Co., St. Louis, Mo. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 20, 1935.

The cost of power requirements can frequently be reduced by a careful combination of the use of high and low pressure steam, Diesel plant and the purchase of electric power. The latter two methods are frequently economies in seasons when low pressure steam is largely wasted. E.F.G.

Discussion: Homogenized Milk Symposium. R. J. QUIRIE, London Ontario, Canada. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 66, 1935.

A survey questionnaire submitted by the Department of Agriculture for the Dominion of Canada and in which 40 Canadian plants participated reveal a wide diversity of plant practice in dealing with homogenized milk problems. From the results of the questionnaire the most generally accepted practices are indicated. E.F.G.

Refrigeration of Trailer Bodies. C. R. MYER, JR., Whiting Milk Companies, Boston, Mass. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 93, 1935.

The advantages and disadvantages of ice, direct expansion ammonia from the plant, brine from the plant, both of the latter distributed through pipes in the sides or top of the 1200 case trailer body; Kold Hold evaporators, blower with flexible air ducts which could be connected at the plant and, lastly, a compressor mounted on the chasis are presented. The latter was considered to be the best and would cost a little more than $600.00 per trailer, which would be saved in less than a season. E.F.G.

The Effect of Metals on Flavor of Dairy Products. H. A. TREBLER, Sealtest System Laboratories, Inc., Baltimore, Maryland. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 107, 1935.

A discussion of the commercial importance of off flavors, their detection and prevention is given. The more desirable metals and alloys for dairy plant equipment are discussed. E.F.G.

Oxidized Flavor in Milk. L. M. THURSTON, West Virginia Univ., Morgantown, West Va. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 121, 1935.

It is shown that copper or iron must be in solution in milk to produce oxidation flavor. Also that samples in which oxidized flavor can be developed by the addition of 1.3 p.p.m. of the soluble copper require about 60.0 p.p.m. of the soluble iron to cause the same intensity of flavor.

Results have shown it is possible to make milk susceptible to the development of oxidized flavor when soluble copper is added by maintaining the cows on a dry feeding régime and to make the milk nonsusceptible by a pasturing régime. Preliminary work indicates that light alone may not develop the flavor.

Both in February and March $\frac{1}{3}$ of the cows in the Experiment Station herd supplying milk for the study of mixed milk were producing milk that became oxidized spontaneously and in April the proportion was reduced to $\frac{1}{8}$ yet the mixed milk never developed oxidized flavor unless copper was added to it. This evidence indicates that it is very unlikely that oxidized flavor will develop in mixed milk of a type usually received at the milk plants unless the milk becomes contaminated with copper or iron after it is drawn from the cows.

All evidence indicates that tinning exposed copper and iron surfaces will prevent the development of oxidized flavor. Although growth of bacteria for a few hours to reduce the oxidation-reduction potential of the milk will prevent oxidized flavor it is probably not advisible and is not necessary if the milk is not contaminated with iron or copper. E.F.G.

Certain Problems Related to the Marketing of Homogenized Milk. P. H. Tracy, Univ. of Illinois, Urbana, Illinois. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 39, 1935.

During a period of three years the percentage of bottled homogenized milk sold by the University creamery increased from 10 per cent at the beginning to about 40 per cent at the end of the three years. The reasons given by the customers themselves for its use were the richer flavor, homogeneous nature, convenience and general adaptability for kitchen use.

Curd tension was usually sufficiently reduced to qualify as soft curd milk with curd tension below 30. Little advantage was obtained in reducing curd tension when homogenization pressures above 2000 were used.

The sediment frequently appearing in homogenized milk was due largely to body cells and possibly to some extent to destabilized casein. Clarification after homogenization at any temperature between 90° and 140° F. prevented the formation of the sediment. Clarification after homogenization was preferable to clarification before homogenization.

A pressure of at least 2000 lbs. at 115° F. or above was desirable to prevent creaming.

Satisfactory Babcock tests on homogenized milk were obtained when both acid and milk were at 70° F. and the acid was added in small portions

with thorough mixing after each addition. About 1.5 cc. less acid was needed than for normal milk.

A determination of the degree of color showed the homogenized milk to have less color, which was explained by the adsorption of an increased protein layer on the increased fat surface.

Frozen homogenized milk presented a normal appearance upon thawing as the usual fat churning was not in evidence.

Homogenized milk was more sensitive to sunlight and became rancid very quickly after homogenization while raw unless heated immediately to pasteurizing temperature.

To insure milk of good keeping quality the following precedure was used when cleansing the homogenizer.

1. When through using, disconnect pipe leading from machine to vat, insert hose in inverted end of pipe leading to homogenizer, turn on cold water. Operate machine with some pressure until water at discharge is clear.
2. Remove all parts from head and then return plugs to lower ports.
3. Permit hot (175° F.) water to flow through machine while in operation from three to five minutes.
4. Wash all removable parts in pail using hot water.
5. Dry machine head and all parts with compressed air.
6. A short time before using assemble machine and pump through at least 50 gallons of chlorine solution (50 parts of chlorine per million).
7. Rinse with cold water immediately.
8. Pump through hot (175° F.) water just before using. E.F.G.

Scoring Milk for Flavor. E. L. Fouts and J. I. Kieth, Oklahoma A. and M. College, Stillwater, Oklahoma. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 116, 1935.

Scoring 5000 samples of milk and employing the chart devised by Fouts and Weaver only six flavor defects were found with decided frequency. These in the order of frequency were as follows:

Flavor criticism	Per cent of all observations
feed	19.7
cowy	15.5
rancid	10.4
stale	8.5
salty	4.7
flat	4.6

When the above criticisms were used alone or in combination with others they accounted for 98.6 per cent of all criticisms made.

Alfalfa hay, when fed before milking, has a marked effect upon the flavor of the milk. The defect was noticeable in 30 minutes or less after feeding, was most intense at about 2 hours and had largely disappeared after 4 hours. The flavor was more intense and persisted for a longer time in Jersey than in Holstein milk.

Cooling without aeration had little effect but cooling and aeration helped to reduce the intensity of alfalfa feed flavor but did not remove it entirely. E.F.G.

Orange Juice and Orangeade for the Dairy Trade. H. H. MATTERN, Bureau of Chemistry and Soils, U. S. A., Washington, D. C. Proc. of 28th Annual Conv. of Intern. Assoc. Milk Dealers, Plant Section, p. 146, 1935.

Definitions of orange juice and orangeade are given, also, an average chemical composition of orange juice. The details of the commercial preparation and preservation of orange juice are given. The author states that carbonated orange beverages now on the market contain from 2 to 10 per cent juice, averaging about 5 per cent. The orange beverages now being distributed by the dairies contain from 10 to 15 per cent juice. Such a high water content, once the public is acquainted with the fact, may reflect upon the quality of the other products distributed by the dairy. The author suggests that the dairy is not primarily in the fruit beverage business and should do nothing to jeopardize its primary interest. He also states that human beings need both milk and orange juice and that dairy orange beverage takes the place of neither.

Vitamin C value of orange juice and orange juice beverages are given as follows:

	Units of Vitamin C per 8 oz. glass	Orange Juice Equivalent
Fresh orange juice	2500	1
Orange juice for dairy trade stored 6 months at 35° F.	2500	1
Dairy orange beverage	200	1/12
Carbonated orange beverage	100	1/25

E.F.G.

Plant Problems in Connection with the Homogenization of Market Milk. R. C. TENNANT, Union Milk Co., Limited Calgary, Alberta.

Canada. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 30, 1935.

The older types of homogenizers should be avoided for milk since they are difficult to clean and the keeping quality of the milk is frequently impaired. The author states that little difficulty with off flavors has been experienced in western Canada when homogenization takes place at 140–145° F. and the pressure kept as low as possible. To avoid trouble from sediment the author recommends mixing skimmilk and cream if a clarifier is not available. Some plants have disposed of returns by making a churned buttermilk from a mixture of homogenized and unhomogenized milk which would leave about 2 per cent fat in the buttermilk. One plant in western Canada which attempted to make cheddar cheese from homogenized milk obtained a satisfactory yield but the cheese was weak bodied, short grained and had a tendency to become bitter and stale in flavor. If homogenized milk returns must be separated or churned this may be accomplished with least loss of fat if the homogenizing pressure is kept as low as possible and the separated homogenized cream mixed with unhomogenized cream before churning in a proportion not greater than one to eight. E.F.G.

Standards for Milk Plant Equipment. WALTER D. TIEDEMAN, Com. on Milk Plant Equipment, Intern. Assoc. of Dairy and Milk Insp., Proc. of 28th Annual Conv. of Intern. Assoc. Milk Dealers, Plant Section, p. 124, 1935.

The plan of the committee is to crystallize the opinions of various groups relative to milk plant equipment. Specifications have been drawn by the committee during the last two years. In drawing these specifications some of the factors given weight were (1) public health efficiency, (2) ease of cleaning, (3) effect of flavor and quality, (4) strength and mechanical dependability, (5) appearance. After the first four factors above have been considered then price may be included with appearance. These specifications are not intended as regulations but merely to crystallize opinion so that through agreement of manufacturers of machinery, the milk dealers themselves and milk control officials more uniform and satisfactory equipment may be evolved. E.F.G.

Can Color of Winter Milk Be Improved? W. E. KRAUSS, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bul. No. 21, 13, June 4, 1936.

Milk from Jersey and Holstein cows fed acid treated alfalfa-clover silage (A.I.V.) contained almost as much yellow pigment (carotene) as is found in milk from Jersey and Holstein cows on pasture. The desirability of

maintaining yellow color in winter milk is discussed from several angles, including the health of the cow and her calf, human health, and sales appeal. W.E.K.

The Influence of Feed Upon the Composition of Milk. NAT. M. ALLEN, Univ. of Minn., St. Paul. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Production Section, p. 69, 1935.

Experiments at the University of Minnesota in 1931 and 1932 have shown that the addition of a number of common animal and vegetable fats including butter fat, lard, tallow, linseed, cottonseed, soybean, corn, peanut and cocoanut oils will result in an increase in the fat content of the milk. The results were so clear-cut that it was possible to determine accurately by milking at frequent intervals almost the exact time required after the fat was fed for its influence to appear in the milk and for this influence to disappear when the feeding of fat was discontinued. Briefly, the experiments showed it was possible to secure as much as 20 per cent increase in butter fat percentages and butter fat production by increasing the daily fat intake one pound or more. While no attempt was made to determine whether the higher fat yields would be maintained indefinitely with continued higher fat intake there was no indication of a return to the normal level after periods of as long as six weeks on the higher level of fat intake.

Recent medical and nutritional research has indicated that the highly unasturated fatty acids occupy an important place in the diet. Under ordinary conditions milk fat is deficient in the fatty acids with two or more double bonds. In dealing with a special grade of milk it is not inconceivable that the type of ration might be considered in improving the nutritive properties of the milk fat in this respect. E.F.G.

The Disposal of Dairy Waste Waters. GEO. W. CAMANAUGH, Cornell Univ., Ithaca, New York. Proc. of 28th Annual Conv. of Intern. Assoc. Milk Dealers, Plant Section, p. 131, 1935.

A description is given of two 10,000 gallon storage tanks used to precipitate the protein material from dairy waste. A prepared mixture of four parts by weight of ferric sulphate and three parts of finely ground limestone gives quite satisfactory results as a precipitant. The ferric sulphate was purchased at $40.00 per ton, and one pound of the mixture was sufficient to clarify 1000 gallons of the waste water from a milk shipping plant. The sludge which on a dry basis had 7 per cent of nitrogen and a high fertilizing value was removed by drawing into tank wagons. E.F.G.

Titratable Acidity as Influenced by Corn Gluten Feed. E. O. ANDERSON AND G. C. WHITE, Storrs, Conn. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 107, 1935.

Two series of trials were conducted using a ration containing 70 per cent corn gluten in the grain mixture compared with a control ration. In the first trial the periods were 20 days each (reversal feeding trial) with a five day interval between periods. No increase in titratable acidity was obtained in the corn gluten ration.

The second trial, continuous feeding for as much as 131 days, failed to increase the titratable acidity. Considerable variation in acidity of the milk from different animals was obtained.

Individuality is an important factor in determining the titratable acidity of freshly drawn cow's milk and accounts for more of the variation in the acidity of such milk than the grain ration. E.F.G.

Properties of Amylase of Cow's Milk and its Relation to the Chief Constituents of Milk. ALFONS SCHLOEMER, German Research Inst. for Food Chem., Munich, Germany. Milchw. Forsch. *17*, 6, p. 326, April, 1936.

The author determined the amylase in milk from the lead acetate serum. The most favorable conditions for the adsorption of amylase out of lead serum were studied with different adsorption media. The amylase was inactivated by the dialysis of the serum apparently because of the removal of electrolytes, especially the chlorides. Reactivation followed the addition of the latter. The Ca ion in the form of chloride played a special role in reactivation in contrast with all other amylases where $CaCl_2$ is similar in action to but no stronger than NaCl. The role of ionizable Ca compounds in milk is also considered. The amylase seemed to be most intimately associated with the serum proteins. A method for obtaining milk amylase is described. H.M.

Part I. The Effect of Bang's Disease on Milk Production. ALEXANDER GOW, JR., AND A. B. HAMILTON. **Part II. Udder Infection in Bang's Disease,** C. L. IVERSON, L. J. POELMA AND A. L. BRUECKER. Maryland Agr. Exp. Sta. Bul. 387, Oct., 1935.

Part I comprises a statistical study of the effect of Bang's disease on milk production of nine herds over a period of four years.

The yearly average for the four years shows there was an increase in income of the non-infected group of $22.35 per cow over that from the infected group.

The milk production for each of the non-infected cows during the four-year period was 6,844 pounds per year with a butter fat content of 281.6 pounds, in comparison with 6,330 pounds of milk and 251.6 pounds of fat from each positive cow. The calvings were at the rate of 1.07 per cow-year in the non-infected group and 0.86 per cow-year for the infected group.

Part II. None of the cattle from which samples were collected, in so far as it was possible to determine, had been infected experimentally or injected with *Brucella abortus* in any form. Cattle which had shown an agglutination reaction on a previous test were chosen as a source of the material. The titres of these animals ranged from a partial at 1 to 25 to a complete reaction at 1 to 200 or higher. Composite samples from the functioning quarters were chosen as suitable materials for determinations. After thorough mixing of the milk sample, portions were withdrawn for the agglutination test and animal inoculation. The blood and milk sera were tested for agglutinins using *Brucella abortus* antigen. Each of two guinea pigs was inoculated subcutaneously with 3 cc. of butter fat and sediment from each sample. All guinea pigs were allowed to remain on test for six weeks, at which time they were destroyed. Blood samples were obtained and the pigs autopsied and lesions destroyed. The presence of *Brucella abortus* agglutinins in the blood serum of the inoculated guinea pig was taken as positive evidence of the presence of *Brucella abortus* in the udder secretions, regardless of whether lesions were present or *Brucella abortus* was recovered from the liver and spleen.

The authors concluded that (1) A high serum agglutination titre was more indicative of udder infection than was a high blood serum titre, (2) Milk serum negative for the agglutination test did not indicate freedom from udder infection, (3) *Brucella abortus* organisms were not found in the milk from any cow whose blood serum did not show agglutinins. C.W.E.

The Quality of Philadelphia Market Milk. H. C. CAMPBELL, GEORGE JAGGARD, AND D. W. CRISMAN, The Dairy Laboratories, Philadelphia, Pa. Milk Dealer *25*, 10, p. 50, July, 1936.

The purpose of this paper is to show the tendency toward high or low results as judged from a few samples in one area. The following conclusions are drawn:

1. *B. coli* content of the four grades of market milk are given, which should aid in suggesting practical limits for the different grades of milk, although the small number of samples run should be carefully considered.

2. Assuming that the sporogenes test is indicative of the original care shown in production, the findings show the milks are graded as we would expect—Certified, first; inspected raw, second; grade A pasteurized, third, and grade B pasteurized, fourth, with appreciable differences between the certified and inspected raw and likewise between grade A pasteurized and grade B pasteurized.

3. Incubation on nutrient agar at 32° C. as judged by this survey on 30 samples of each group would not seriously alter the grade of any of the four market milks.

4. Substitution of trypsin digest skimmilk agar for nutrient agar and incubation at either 32° or 37° C. as judged by 30 samples of each group.

(a) Would increase the counts of certified milk approximately 50 to 60 per cent although this increased average is only 36 per cent of the maximum allowed.

(b) Would concern the producers of inspected raw milk as the average counts are above the 20,000 requirement for inspected raw milk.

(c) Would cause occasional samples of grade A pasteurized milk to exceed the 30,000 requirement. Average counts are increased 135 per cent although the increased average is approximately 10,000.

(d) Would materially raise the counts on grade B pasteurized milk and cause occasional samples to fail to meet the requirement, although the averages are approximately 20,000 at 37° C. and 30,000 at 32° C. C.J.B.

Methods of Control Infectious Bovine Mastitis. E. O. Anderson and W. N. Plastridge, Storrs Agr. Exp. Sta., Storrs, Conn. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Production Section, p. 75, 1935.

A study of 300 strains of streptococci from healthy and diseased udders show that the streptococci isolated from the bovine udder may be divided into the following three principal groups. (1) A group containing saprophytes only, (2) one designated as Group B which is associated with a mild form of mastitis of relatively short duration, and (3) a group designated as Group A or *Streptococcus mastidis* which was responsible for at least 90 per cent of the instances of persistent chronic mastitis in the herds under study. A satisfactory method upon which to base the segregation of infected animals must include identification of the species or type of organism found.

This paper is concerned with the incidence of mastitis in bacterin-treated and untreated groups and the presentation of a plan for the control of infectious chronic mastitis by periodic laboratory examinations and segregation of affected animals. A review of past work in this field is presented and an outline of experimental methods given.

In general, the results obtained with bacterins show that (1) periodic injections of autogenous herd bacterins fail to bring about complete recovery of affected animals; (2) they reduce but slightly the rate of spread of infectious mastitis, and (3) they apparently aid somewhat in retarding the occurrence of milk abnormal in appearance by animals recently affected with the disease.

Determination of the relation of the lactation period to evidence of mastitis in two badly affected herds showed that the incidence of laboratory evidence of mastitis, shedding of streptococci and yielding of milk abnormal in appearance increased at a fairly uniform rate with each succeeding lactation period. First calf heifers were usually free from mastitis for several months following parturition. Thereafter the incidence of mastitis increased steadily until all animals that reached the ninth lactation period

gave consistently positive evidence of mastitis by laboratory tests and yielded milk abnormal in appearance at irregular intervals.

The plan of control submitted is briefly as follows:

Examination of the milk of individual cows by eight different tests permits placing the milking animals of the herd in five groups, the first classed as negative and the last containing animals showing positive evidence of mastitis due to Group A streptococci. First calf heifers added to the herd are placed at the head of the list in Group I. Mature animals calving after the initial test are not added to the milking herd until samples of milk have been examined. Animals in the last group are disposed of as rapidly as possible. The authors state that results thus far indicate that infectious mastitis may be effectively controlled by this method. One herd established over 2 years ago failed to show the presence of either group A or Group B streptococci in bacteriological tests made at 30-day intervals. A modified plan is proposed when laboratory facilities are not available.

E.F.G.

Results of Bacteriological Survey of Milk Jugs and Milk Bottles. S. V. Layson and E. G. Huffer, Ill. Dept. of Health, and J. M. Brannon, Univ. of Ill. Milk Plant Mo. *25*, 2, 1936.

Methods of operating bottle washers and handling bottles following washing were largely responsible for high bacterial counts, both in jugs and in bottles rather than the machines themselves. Figures are presented showing that jugs and bottles can be put in good condition bacteriologically. Also, that the bacteriological condition of many jugs and bottles is such that they should not be filled with milk. G.M.T.

Comparative Fairness of Single Can and Weigh Vat Samples for Bacterial Counts Used as Basis of Premium Payments to Grade A Dairymen. M. W. Yale and R. S. Breed, N. Y. State Agr. Exp. Sta., Geneva, N. Y. Proc. of 28th Annual Conv. Intern. Assoc. of Milk Dealers, Laboratory Section, p. 94, 1935.

Eleven hundred samples from 178 dairies were collected at 3 Grade A New York plants. In 13.2 per cent of the 178 cases the dairyman had a chance of obtaining a better premium with a combination of a P. M. and A. M. can than with the weigh can sample while in 24.5 per cent of the cases he has a poorer chance of obtaining the same premium. However, at two of the three plants the number of cases in which the vat sample was more severe just about equaled the number of cases in which it was more lenient, so that the above differences in precentages are probably not significant. In measuring the effect of residual milk in the weigh tank 36 cases out of 178 (20.2 per cent) yielded counts in which composite samples from cans placed the milk in a different premium class than those from the weigh can. In 16

instances vat counts were in a lower premium class than composite samples from cows and in 20 instances in higher premium classes. It was concluded that the routine standard plate counts were not sensitive enough to measure contamination of the vat sample with residual milk. In a second study 197 samples were taken from 48 dairies. From these it was concluded that very careful technique with triplicate agar plates indicated that the counts measured weigh vat contamination to a slight degree.

In the above work only 2 cases of counts over 100,000 were obtained, one occurring in each of the two studies.

While some indication has been obtained that a change from single can to weigh vat samples will have but little effect on total premium returns and that premiums are seldom lost through contamination of the vat sample with milk from the preceding dairy, definite conclusions are not justified at this time. At least a year of vat sampling would be needed to determine this. Errors in plate counts are greater than are desirable in a method used as a basis of payment. Changes in laboratory methods should be made which will reduce errors in bacterial counts to a practical minimum and which will more nearly indicate the true qaulity of the milk delivered by the dairyman. E.F.G.

Facing the Facts on High Temperature Pasteurization. GEO. W. PUTMAN, The Creamery Package Manufacturing Co., Chicago, Illinois. Proc. of 28th Annual Conv. of Intern. Assoc. Milk Dealers, Plant Section, p. 138, 1935.

High temperature pasteurization was first tested and accepted by the Pennsylvania State Health Department in 1927. A census by Irwin, of the Pennsylvania State Health Department, showed 76 plants are now using either the electric or hot water type of high temperature pasteurizers. Advantages of this method of pasteurization include lower initial investment in equipment, smaller floor space, and some saving of time in cleaning. Also bottling can be started earlier.

The disadvantages include the following:

The very narrow margin between effective pasteurization and injury to cream layer, the destruction of cream layer on a considerable quantity of milk before and after shut down, the higher milk temperature may result in more metal being dissolved which in turn may increase a tendency to cappy flavor; milk stone accumulations are greater and more difficult to remove; specifications by the U. S. Public Health Service relative to automatic controls render practical operation more difficult. For various reasons, some of which have been enumerated above, eight plants which have come to the author's attention have discontinued high temperature pasteurization.

Each leader contemplating high temperature pasteurization should carefully consider how this process will fit into his own plant operations before making a decision. E.F.G.

A Study of Sanitary Quality of Milk Unsupervised Sources in Illinois. H. A. RUEHE, Univ. of Illinois, Urbana, Ill. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Production Section, p. 3, 1935.

This study, a cooperative one between the University of Illinois and the State Department of Agriculture, was to determine the quality of raw milk being sold throughout the state outside of those cities which have satisfactory milk control ordinances. The samples were taken in 54 counties in the northern two-thirds of Illinois from November, 1934, to February, 1935, inclusive. Of 1,720 samples, 41, or 2.38 per cent, were below the legal standard of 3.0 per cent fat, while 71, or 8.58 per cent, were below the legal standard of 8.5 per cent solids-not-fat. Of the 1,720 samples 417, or 24.24 per cent, contained at least 5.0 per cent fat, while of the 827 samples, 146, or 17.65 per cent, contained 9.5 per cent and over of solids-not-fat.

Bacterial counts on 1,713 samples showed 227, or 12.80 per cent, below 10,000 per cc. and 150, or 8.47 per cent, above 1,000,000 per cc.

The sediment tests on 1,493 samples indicated that about half the milk was being filtered through sanitary pads and half through wire or cloth strainers.

Agglutination tests on 1,424 samples gave 20.01 per cent positive. The presence of streptococci causing mastitis was demonstrated in 15.11 per cent of 728 samples. Positive tests for *Escherichia coli* were obtained on 20.97 per cent of 372 samples.

The author considers that the food value of the samples examined does not present a problem but that there is a positive health problem in the results of the abortion, mastitis, and coli tests. E.F.G.

Significance and Control of Intestinal Bacteria in Milk Products. O. K. PALLADIA AND T. A. KROTOWA. Central Fat Inst., Leningard, U. S. S. R. Milchw. Forsch. 17, 5, p. 212, Dec., 1935.

Eberthella typhosa, Salmonella schottmuelleri, Escherichia coli, Aerobacter aerogenes and a food-poisoning bacillus called *B. Breslau* (*Salmonella enteritidis?*) alone or in combination with lactic acid rods or cocci, grow well in milk. An acidity equivalent to pH 4.2 is critical for these types although they survived for considerable periods at a higher pH. With a combination of 5 per cent NaCl at pH 4.6, the intestinal types were destroyed within 24 hours. During the manufacture of butter and margarine, the intestinal types increase steadily, so in order to control them the authors recommend rapid souring of cream and prompt salting of the butter.

H.M.

Seasonal Influences on the Quality of Milk and Some Methods Serving for their Estimation. KARL ECKL, Dairy School and Research Station, Friedland, Germany. Milchw. Forsch. *17*, 5, p. 193, Dec., 1935.

Bacterial counts were made on 937 samples of milk. Marked seasonal fluctuations were shown by total counts on China blue lactose agar with incubation at 30° C. for 4 days plus 1 day at room temperature, methylene blue reduction time, fermentation tests at 38° C. for 24 hours and *E. coli* tests by Neisser and Frieber indol method. High counts prevailed and the lack of prompt and efficient cooling was evident. The various tests were subject to discrepancies at certain seasons and the authors emphasize the importance of selecting the proper test for the particular season involved.

H.M.

Contributions to the Biochemistry of Microorganisms. VII. Knowledge of Bact. linens. W. GRIMMER AND JOSEF SCHMID. Univ. of Königsberg, Germany. Milchw. Forsch. *17*, 6, p. 286, April, 1936.

Data are presented on the decomposition of casein, in the presence or absence of dextrose, by *Bact. linens* Weigmann, a species isolated from the slime of Tilsiter or Limburger cheese. H.M.

Influence of the Nutrition Medium and Oxygen Tension on the Acid and Alkali-forming Ability of Slime-formers of the Aerobacter Group. JOHANNES RODENKIRCHEN, Univ. of Königsberg, Germany. Milchw. Forsch. *17*, 6, p. 303, April, 1936.

Slime-forming cultures, closely related to *Aerobacter aerogenes* and *A. cloacae*, considered as strong alkali-producers on the basis of their action on China blue lactose agar, formed only acid as a rule in lactose broth under anaerobic culture and in milk under aerobic or anaerobic conditions. The same types usually exhibited a marked reducing action in China blue milk but in China blue lactose broth reduction repeatedly appeared simultaneously with alkali formation. The importance of medium and oxygen tension in determining the biochemical activities of bacteria is emphasized.

H.M.

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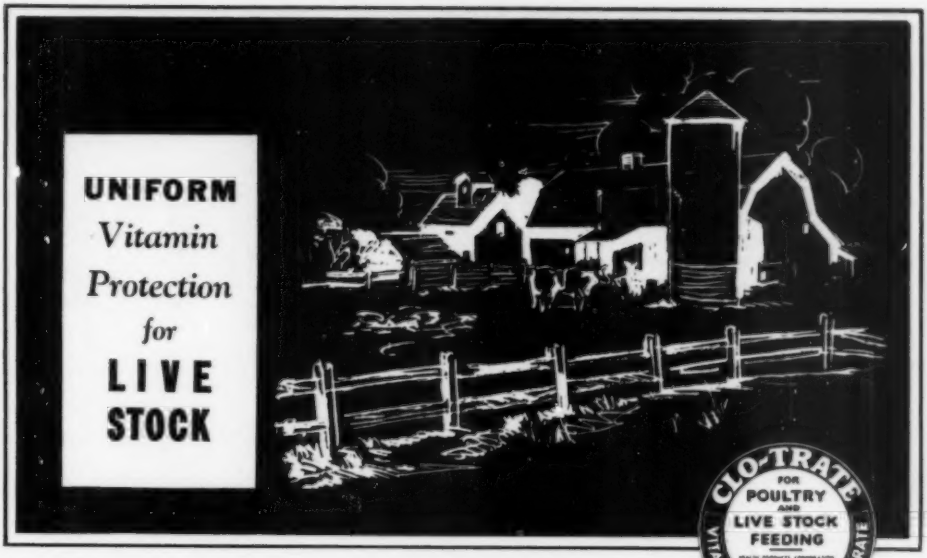

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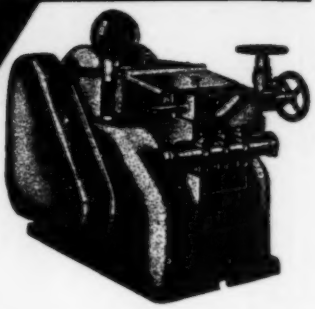

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